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ANNUAL REPORT

1958

RUBBER RESEARCH INSTITUTE OF MALAYA

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ANNUAL REPORT

1958

Corrections

1957 Annual Report

Page	
34	*Line 4, for* Gleichenia linearia *read* Gleichenia linearis
46	*Line 5, for* 2C/2.d/2.100% *read* 2C/2.d/2.200%

RUBBER RESEARCH INSTITUTE OF MALAYA

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The Rubber Research Institute of Malaya

The Institute was established under the Rubber Research Institute of Malaya Enactment 1925, amended in 1934. It was founded for the purpose of research into rubber production in all its aspects and for the provision of information on the results of research. Funds are provided by a voluntary cess on the exports of rubber from Malaya. Contributions are also received from other producing territories—Nigeria, Sarawak, Brunei and North Borneo. The Institute is administered by a board consisting of Government nominees and selected representatives from planting organisations.

Three Divisions, Soils, Botanical and Pathological, are concerned with the cultivation of the rubber tree and the harvesting of the crop. The Chemical Division carries out investigations into the conversion of the crop into marketable forms. There is also a Statistical Section and a Publications and Information Section which includes the Library.

The Smallholders' Advisory Service has the task of conveying the results of research to the large rubber smallholding community of Malaya. An Estates Advisory Service has also been formed which will provide routine advice to all estates, that is all planted areas over 100 acres.

The main research buildings are at Kuala Lumpur. The Experiment Station, about 3,000 acres in extent, is at Sungei Buloh, 16 miles from Kuala Lumpur.

Report of the Board

The Board. The constitution of the Board remained as prescribed by the R.R.I. Enactment No. 14 of 1934. The members at 31 December 1958 were:

a. The Director of the Institute, Chairman, *ex officio*

b. An Officer of the Treasury, Federation of Malaya, Financial Member appointed by the Minister of Commerce and Industry

c. The Director of Agriculture, Federation of Malaya, *ex officio*

d. Members appointed by the Minister to represent the interests of smallholders
   The Hon'ble Enche Abdul Jalil bin Haji Aminudin, P.J.K., J.P.
   The Hon'ble Mr Yap Kim Hock, J.P.

e. Members appointed by the Minister for a panel nominated jointly by the Rubber Growers' Association, the United Planting Association of Malaya and the Malayan Estate Owners' Association
   Mr J. C. Mathison, O.B.E.
   Mr S. Sandison, B.Sc.
   The Hon'ble Mr A. W. Goode
   Mr J. Brown
   Mr Choo Kok Leong

Of the members appointed under Section (d) Mr Yap Kim Hock was appointed for three years from 1 September 1958.

Of members appointed under (e), Mr R. A. Coles was serving at the opening of the year, but resigned upon his retirement from Malaya when Mr S. Sandison was appointed for three years with effect from 1 December 1958.

Mr J. C. Mathison was absent from Malaya on long leave for five months and Mr L. H. N. Davis was appointed to act for him; Mr J. Brown was on long leave for five months and Mr S. J. Nias was appointed to act in his place.

At the close of the year the members of the Board appointed under (a), (b) and (c) were, respectively, Mr C. E. T. Mann, Mr C. L. Robless, M.C.S. and Mr P. G. Coleman.

The Permanent Committee consists of five members of the Board:
   The Director of the Institute, Chairman, *ex officio*
   The Financial Member, *ex officio*
   Three members appointed by the Minister

At 31 December, 1958 the three appointed members were:
   The Hon'ble Enche Abdul Jalil bin Haji Aminudin
   Mr J. C. Mathison
   Mr Choo Kok Leong

During the year the Board held three statutory meetings and the Permanent Committee met five times. *Ad hoc* Committees of the Board were appointed to deal with building and housing matters, and also revision of service conditions and regulations.

Policy. The Board continued to develop the policy of expansion of the work of the Institute in accordance with those recommendations contained in the Report of the Blackman Committee which were approved by the Government of the Federation and supported by the Rubber Producers' Council.

The principal lines of development of the programme of work, as set out in the Board's Report for the year 1957, have been followed and further considerable progress has been made. (See pages 4 and 5 of the *Annual Report* for 1957).

During the first quarter of the year a Sub-Committee of the Board, under the Chairmanship of Mr J. Brown, undertook a complete review of salary scales and conditions of service of all categories of staff employed by the Board. The Report of this Committee was considered by the Board at the Statutory Meeting in March 1958 and its main recommendations approved and implemented.

The Board has now established a unified Senior Staff service consisting of Division A and Division B for graduate officers engaged in research, technology and advisory services. Qualifications for appointment to Division A are honours degree status at an accepted university with a minimum of two years post-graduate research or other equivalent qualifications and experience. Officers for appointment to Division B must hold a good pass degree or diploma of an accepted university or college.

It is now the policy of the Board to give first preference to Malayan Citizens followed by candidates from Commonwealth countries for appointment to all future vacancies that arise in Divisions A and B, subject to the selection of men best qualified for each post. In future it is expected that most new appointments to the graduate staff will be made in Division B and that the Board will select outstanding officers in Division B for additional training, either in Malaya or overseas, in order that they may qualify for promotion to Division A.

Towards the close of the year a new Ordinance, The Malayan Rubber Fund (Research and Development) Ordinance 1958 was enacted; the text of the Ordinance is included in the *Appendix* to this Report. The new Ordinance provides for the appointment of a Controller of Rubber Research, who will be Chairman of the Malayan Rubber Fund Board, and for more closely integrated control of the activities of all bodies financed from the Malayan Rubber Fund.

The post of Controller of Rubber Research was advertised in June 1958 and the Board was informed in December 1958 that Sir Geoffrey Fletcher Clay, K.C.M.G., O.B.E., M.C., formerly Adviser on Agriculture to the Secretary of State for the Colonies, had accepted the appointment and would take up his duties in the Federation of Malaya early in 1959.

It is expected that further notable administrative changes will take place during 1959, in accordance with the terms of the Malayan Rubber Fund (Research and Development) Ordinance of 1958 which places the affairs of the Rubber Research Institute of Malaya, The British Rubber Producers' Research Association, the Natural Rubber Development Board and Rubber Technical Developments, Ltd within the portfolio of the Minister of Commerce and Industry, Federation of Malaya.

Finance. The rate of cess collection for the Malayan Rubber Fund, under Schedule III of the Customs duties on rubber produced in and exported from the Federation and Singapore, was raised (with effect from 6 February 1958) from 0.50 cents a pound to 0.75 cents a pound and remained at the latter level for the rest of the year.

The Board's approved estimates of total expenditure and revenue together with statements of actual expenditure and revenue (as shown in the audited accounts at the end of this Report) are shown below:

	Approved Estimates	*Expenditure*
	$	$
Headquarters and Laboratories	5,434,898	4,760,372
Experiment Station, Sungei Buloh	1,318,320	1,211,149

Underspending of the Board's approved allocation on Headquarters and Laboratory votes is accounted for mainly by the delay in obtaining Senior Staff in Division A to fill new appointments and initiate new projects approved under the plans for expansion recommended by the Blackman Committee. However, during the year new appointments were made to fill most of the outstanding vacancies and officers appointed assumed duty in the closing months of the year. The Board is indebted to the Chairman, Secretary and Members of the London Advisory Committee for Rubber Research (Ceylon and Malaya), for their assistance in the selection of candidates for appointment.

Revenue. Total revenue on Headquarters account, which arises from fees for certain advisory services, sale of scrap rubber, rental of houses and interest on investments and other miscellaneous receipts, amounted to $91,180. Revenue accrued from the sale of rubber and planting material produced on the R.R.I. Experiment Station, refund of cess contributions under the Rubber Industry (Replanting) Ordinances and allowances for new planting and replanting together amounted to $998,361, giving a total revenue of $1,089,541.

By an arrangement agreed with the Controller of Rubber in 1949, the Board receives no direct financial contribution from the Malayan Rubber Fund for the operation of the R.R.I. Experiment Station. The Station is regarded as a self-supporting unit and all expenditure on its operation, including capital expenditure on the purchase of land, the establishment of new experimental plantings, replanting and expansion of factory facilities and buildings (other than research laboratories and research staff quarters at Sungei Buloh), is provided out of revenue. There is, however, a proviso that in any year when the accounts for the Station show an excess of expenditure over revenue the difference will be met from the reserves of the Malayan Rubber Fund. Conversely, in any year when there is a profit on the operation of the Experiment Station this profit is to be paid into the Malayan Rubber Fund.

The Malayan Rubber Fund. In order to show the relationship between the expenditure on research, advisory and development work undertaken by the Board of the R.R.I.M. and that allocated to other organisations financed by the Malayan Rubber Fund Board, an analysis of revenue and expenditure of the Malayan

Rubber Fund during 1958, extracted from the audited accounts of the Fund published in the Government Gazette, is given below:

Income and Allocations from the Malayan Rubber Fund 1958

Income	$	*Allocation as % of total revenue*
Schedule III—Cess at 0.5c/lb from 1.1.58 to 5.2.58 and at 0.75c/lb from 6.2.58 to 31.12.58 on exports from Federation	10,187,323	97.58
Cess collection from the Colony of Singapore	12,585	0.12
Cess from concessional estates	103,167	0.99
Interest from investments	136,880	1.31
Total	$ 10,439,955	100.00
Expenditure		
Administration: Controller's Office	25,056	0.24
Contributions to:		
Rubber Study Group Secretariat	7,114	0.07
Rubber Research Institute of Malaya	6,149,437	58.90
British Rubber Producers' Research Association	1,787,601	17.12
Natural Rubber Development Board	1,498,499	14.36
Rubber Producers' Council of F. of M.	93,200	0.89
Malayan Trade Exhibit at Singapore	25,000	0.24
Total	$ 9,585,907	91.82
Excess of Income over Expenditure	$ 854,048	8.18

In addition to the amounts received from the Malayan Rubber Fund the Research and Development organisations received the following contributions:

R.R.I.M.—Nigeria $13,371.43; Brunei $3,700; N. Borneo $27,471.58

B.R.P.R.A.—Nigeria £840; Brunei £431.13.4; N. Borneo £581.7.7.; Ceylon £11,250; Sarawak £4,375

N.R.D.B.—Nigeria £$00; Brunei £303.6.8; N. Borneo £348.16.6; Sarawak £2,975

Special contribution. Singapore Chamber of Commerce Rubber Association for Publicity paid £6,650.18.10 directly into the Malayan Rubber Fund.

Programme of research and advisory work, 1959. The Board submitted detailed Programmes of Work for the year 1959 together with Estimates of Expenditure totalling $6,920,593 to cover all expenditure both capital and revenue required to implement the approved programmes of work.

Special provision was included in the Estimates for expansion of advisory services, both the Estates Advisory Service and the Smallholders' Advisory Service. The Estimates were accepted by the Controller of Rubber, and the Malayan

Rubber Fund Advisory Committee, and a contribution of the above mentioned amount was approved from the Malayan Rubber Fund. Approval was subject, however, to such further revisions as might be recommended during 1959 by the Controller of Rubber Research, designate, and the Malayan Rubber Fund Board.

Staff position. The Senior Staff position, including the new Divisions A and B, improved during the year and 7 Senior Officers in Division A were engaged. At the end of the year there were 5 vacancies for senior staff. Including additions to the staff approved for employment in 1959, there were 8 vacancies as at 1 January 1959.

With regard to recruitment of junior staff, the position was very good and the Institute had no difficulty in attracting recruits with very good school qualifications for appointment as laboratory and field assistants and to clerical posts. However, in the Smallholders' Advisory Service the recruitment of Rubber Instructors who are now most urgently required was limited by the facilities for training of Diploma Students in Agriculture at the Federal College of Agriculture, Serdang. At the close of the year the Board was financing eleven scholarship holders at the College.

C. E. T. Mann
Chairman of the Board

Report of the Director

The revised programme of research discussed in last year's report was successfully followed in 1958. Advances in research and important developments in advisory work are outlined below.

SOILS DIVISION

Research

Effect of fertilisers on growth. As in previous years, the growth rate of *Hevea* increased in response to nitrogen (nine trials) and phosphate (six trials). There was a marked response to nitrogen in the younger immature areas. Potash application gave an increase in growth in one trial and a decrease in three trials.

In an area of twenty-year-old budded rubber, previously showing magnesium deficiency, up to 3 lb per tree of magnesium limestone gave improved growth.

Effect of fertilisers on yield. Annual yield records from twenty-four manurial experiments were analysed during the year. Nitrogen and phosphate gave increased yields. There was an indication that the effect of nitrogen is enhanced when potash is added.

Weed control. In the control of grasses and herbaceous weeds, dalapon and aminotriazole have a more persistent effect than sodium arsenite, sodium chlorate or Lallicide (TCA). Dalapon applied at six-monthly intervals gives good control of weed communities dominated by *Axonopus compressus,* provided *Paspalum conjugatum* is absent. The latter grass is effectively controlled by aminotriazole.

Various alternatives to sodium arsenite were tested for routine control of weeds along rubber planting rows. As *P. conjugatum* was the dominant grass in the area where the test was carried out, dalapon was ineffective. Lallicide was only slightly better. Aminotriazole suppressed the grass weeds but there was subsequent invasion by *Mikania scandens* and regeneration of legumes. The most effective control was obtained with sodium chlorate sprayed at two-monthly intervals.

Ground covers. Experiments to determine the effect of different cover plants on the nutrition and growth of young rubber have been continued. In the first year after planting there was no significant difference between the effects of the various covers on seedling height.

Further evidence was obtained that young rubber trees grew faster when legume covers in the planting rows were strip-weeded than when they were circle-weeded.

In three small-scale trials on inland soils the growth of mixed legume covers was markedly improved by applications of up to 3 cwt of rock phosphate per acre.

Soil investigations. Laboratory tests of the mineralisation of soil nitrogen continued. High temperatures comparable with those in exposed soil surfaces in the field inhibited nitrification. Both ammonification and nitrification were lower in soil at one-sixth water-holding capacity than at higher moisture contents.

Plant investigations. The effects of NPK applications on the mineral composition of leaves and latex is now being investigated in a field experiment. The first results of chemical analysis are presented in this report. A similar study of the effects of trace elements is being made.

Pot-sand-culture experiments. An investigation was conducted into the requirements of *Hevea* for nitrogen, phosphorus, magnesium and manganese. In the early stages of growth, the need for added nitrogen was apparent first. Up to three months after planting the germinated seed, the requirement for magnesium and manganese was greater than for phosphorus; but the position was reversed in later stages.

Nutrient deficiency symptoms in the cover plants have been induced and recorded in a series of experiments; records of the visual symptoms have now been made for *Pueraria phaseoloides, Centrosema pubescens* and *Calopogonium mucunoides.*

Advisory

Advisory correspondence increased by 50 per cent and the number of estates visited increased from 61 to 103. Manuring continued to be the centre of interest in advisory work. Magnesium deficiency is widespread and fertiliser mixtures containing this element are increasingly used. Manganese deficiency was observed in several areas, notably in South Johore.

A new feature in advisory work was the number of requests for advice on the suitability of land for rubber planting in the large-scale state-organised land settlement schemes. Several thousands of acres were inspected.

BOTANICAL DIVISION

Research

The main items of the botanical programme are: breeding and selection; propagation and planting techniques; investigations of tapping methods including yield stimulation; physiological studies of the rubber tree; and ecological studies of cover plants.

Breeding and selection. Results in the hand pollination programme were below average owing to adverse weather conditions. The tenth year of tapping of most of the large scale trials of RRIM 500 series clones trials has now been completed. RRIM 501, 513 and 519 retain their leading positions. Of these, RRIM 501 gives the greatest early gain but the two other clones, especially RRIM 513, appear to have sustained their yields better over the whole period owing to resistance to wind damage and better secondary characters.

Trials at the R.R.I. Experiment Station with clones RRIM 600–618 and 619 — 630 are in the third and second year of tapping respectively; the most promising clones at the end of the year appeared to be RRIM 600, 603, 605, 606, 607, 610 and 623. RRIM 606 is a new addition to this list, RRIM 614 is withdrawn on account of susceptibility to wind damage. RRIM 628 gave an exceptionally high yield of 1850 lb per acre, but its performance must be confirmed before it can be added to the list.

Vegetative propagation. Mr R. J. Garner, Head of the Pomology Division of East Malling Research Station visited Malaya for a period of four months to initiate work on new methods of vegetative propagation. The object of this work is to establish a method of propagation of clones by cuttings and to produce uniform clonal stock material.

Tapping systems. Over a period of eleven years of tapping, yields from half spiral alternate daily tapping have exceeded those from full spiral fourth daily tapping on all clones except Pil D65 in one experiment.

Periodic full spiral systems of varying intensities have been tested. The most promising of these are full spiral third daily periodic systems of 100 per cent intensity.

In experiments to test the suitability of various tapping systems for material subject to brown bast, Prang Besar Further Proof Seedlings have been successfully tapped alternate daily for three years with no reduction of girthing compared with third daily tapping. Where yield stimulants have been applied to tasks in this experiment, girth increase has been retarded and the number of dry trees increased.

Information from long-standing experiments on intensive tapping was fully reported in *Planters' Bulletin 38* where a distinction was made between correct tapping systems for old high-yielding clones and other old material.

Physiology. Important fundamental studies of the physiology of the rubber tree continue; they include investigations of yield stimulants and their mode of operation and the chromatography and bio-assay of naturally occurring plant growth substances.

Wind damage. Extensive damage of trees has occurred in certain districts and some high-yielding clones hitherto thought to be wind-fast have now proved susceptible. The subject of wind-damage and its prevention is therefore receiving urgent attention.

Seed treatment. Numerous laboratory and field trials are in progress to test methods of treating leguminous seeds to improve germination. A practical method of mechanical scarification has been devised. Another successful type of pre-treatment involves soaking seeds in glycerine and the addition of ground rock phosphate.

Advisory

A further increase occurred in the amount of advisory correspondence, mainly concerning choice of planting material and planting practices.

Sixty-six advisory visits were made by Research Officers and two hundred and fifty estates visited by Clone Inspectors.

Cover plant seeds were tested and distributed to estates.

PATHOLOGICAL DIVISION

Research

Root diseases. As in previous years the main effort of the Division was concentrated on root diseases. Studies of *Fomes lignosus* (white root disease) infection will be assisted by a technique of pure culture inoculation which has now been developed. Preliminary investigations indicate that reproducible infections by pure cultures may now be obtained which will permit studies of variations of fungal pathogenicity and of resistance by the host tree.

In a test of more than sixty fungicides and other chemicals *F. lignosus* showed remarkable tolerance to a wide range of compounds.

None of the collar fungicides so far tested has entirely prevented superficial growth of root disease fungus from reaching the collar.

An experiment is now in progress to determine the effect of root disease on yield, latex composition and the nutrition of the tree. The three other Divisions are collaborating in recording yield and making the necessary analyses.

Determinations of growth rates of different isolates of *F. lignosus* at two pH levels have led to the conclusion that varying strains exist in the field.

Field experiments and numerous field observations have shown the important part played by spore infection in the spread of root disease. Incidence is considerably lowered by the application of a wood preservative such as creosote to the cut surfaces of tree stumps.

A further experiment was laid out this year for the study of the rate of decay of rubber wood. The influence of tree poisons on decay is being investigated and the part played by insects in the process of decay is being assessed.

Leaf diseases. Mercurised copper oxychloride was the most effective fungicide against bird's eye spot. Trials are now aimed at improving the technique of applying the fungicide.

Pests. The relative persistence of the toxicity of dieldrin and aldrin against termites *(Coptotermes curvignathus)* has been shown to vary with different soil types. None of the chlorinated hydrocarbons proved persistent in peat soils.

Aldrin was shown to be an effective and persistent soil treatment against the cockchafer *Holotrichia bidentata.*

Advisory

Root disease enquiries continued to demand most attention. Numerous requests for identification of root diseases, both on rubber and cover plants, were received.

The demand continued for packaged *Rhizobium* compost culture for the inoculation of legume cover plant seeds. Over 11,000 packets were distributed.

CHEMICAL DIVISION

Research

Biochemistry of latex. New techniques for resolving latex proteins have been tried with considerable success. One method has demonstrated the presence of at least seventeen different components in the serum separated from fresh latex by high speed centrifuging.

Progress has also been made in distinguishing the components of the bottom fraction separated from fresh latex by high speed centrifuging, and in determining the conditions under which volatile fatty acid is formed in latex concentrate.

Microbiology of latex. Further trials have been made of the application of bactericides to rubber trees, with a view to studying their effect on yield and latex quality. Treatment of the scraped tapping panel with vaseline containing antibiotics has generally given increases in yield comparable with those obtained with the yield stimulant 2,4,5-T.

Colloid chemistry. Studies have been continued relating the colloidal stability of latex with its behaviour on coagulation. Latex coagulum has been shown to be a visco-elastic material in which the elastic elements predominate over flow

elements. These properties determine the way coagulum behaves in machining and are being studied further.

Polymer chemistry. Studies of the grafting of polymethyl methacrylate side chains on to the rubber molecule have demonstrated that improved properties can be obtained by this means. A novel method of initiating polymerisation has been developed which employs aeration of fresh latex, and yields graft polymers which show greater coagulum strength and improved film-forming characteristics. Fundamental studies of the rubber hydrocarbon continue.

Thiol acid rubber. An improved method of preparing thiol acid rubber has been developed. Thiol acid prevents the hardening or crystallisation of natural rubber when used at low temperatures.

Drying of coagulum. An investigation has been completed in which the effects of temperature, humidity and sheet thickness on the drying rate and properties of rubber were determined.

Applied Research and Development Work

Latex. Experimental trials are in progress on two estates to determine the effect of manurial treatment on latex properties.

New systems of preserving latex concentrates with low levels of ammonia have been successfully developed.

Foam rubber. Facilities for foam rubber preparation and testing have been improved to bring our methods into line with current practice in Great Britain so that a preliminary assessment of new types of latex designed for use in foam rubber manufacture can now be made.

Rubber technology. The addition to latex of certain materials, such as formaldehyde and cetyl pyridinium bromide (Fixanol), modifies vulcanisation characteristics of the rubber prepared with it. Further work with these materials has established more clearly their effect upon stress/strain characteristics.

Considerable advances have been made with Superior Processing rubbers and two new forms have been developed to the stage of pilot plant production. Brown crepe, both estate and remilled types, can now be prepared having SP characteristics and 10 tons have been produced in our factory at Sungei Buloh.

A concentrated form of SP rubber, SP 90, has also been developed. This is a processing aid which confers SP characteristics on any type of rubber.

Application of some of our observations on the drying of rubber have been applied to the design of drying houses and it has been demonstrated that a higher level of insulation could probably be introduced with advantage in the majority of existing driers.

Process evaluation. Work on the disposal of effluents from rubber factories has continued and a full scale plant has been constructed at our Experiment Station, Sungei Buloh. Trials with the plant have just commenced and some results are presented in this Report.

Advisory

The volume of enquiries from estates and factories remained at much the same level as in previous years.

Sheet and crepe. There was increased interest in factory planning for sheet production. The number of oil-heated air circulating tunnels in operation has increased to about sixty throughout the Federation and problems arising from their use have been dealt with.

Crepe rubber production was at a low level throughout the year and fewer enquiries were received regarding its production. Advice has been given on bleaching and drying.

Latex concentrate. 1958 proved to be a record year for latex concentrate production; a high level of quality of all types of concentrate has been maintained throughout the year. Advice sought has dealt largely with cleanliness and efficiency of factory operations. Considerable interest has also been shown in methods of producing the new types of latex concentrate.

Special rubbers. A small tonnage of cyclised rubber was produced during the year, and there was a marked increase in output of SP rubber.

Technical classification. The number of estates participating in the scheme for Technical Classification rose from 83 in January to 92 in December. Classification has continued on the basis of the quality control chart, but a few estates worked satisfactorily using classification by lot. The estimated total production of T.C. rubber in Malaya and British North Borneo in 1958 is 29,619 tons.

SMALLHOLDERS' ADVISORY SERVICE

For some time a limiting factor in the work of the Smallholders' Advisory Service has been the shortage of staff of all grades. During 1958 the staff at Headquarters was increased to four senior officers. With this increase in senior staff, the administration of the Service was changed.

From 1 December all field staff were supervised direct from the Institute instead of by officers of the Department of Agriculture as had previously been the practice. We wish to express our gratitude to the Department for its very valuable administrative assistance in the past.

Approval was obtained for an increase in the number of Junior Rubber Instructors to ninety. Following a training course, seventeen Junior Rubber Instructors were offered appointment from 1 January, 1959. Three new Rubber Instructors were also appointed.

Organised training courses for groups of smallholders have continued as a major part of the work of the Service. Courses at three standards were held during the year and completed by 311 students.

A number of land development schemes for new planting of rubber by groups of smallholders were started with financial assistance from the Federal Land Development Authority. Visits were made to a number of these schemes and technical advice given during the planning stages. Rubber Instructors and Junior Rubber Instructors will provide more detailed advice as the schemes develop. New planting of 10,837 acres by individual smallholders was reported. Only 34 per cent of this area was planted with clonal seedling material compared with 72 per cent in 1957 new planting. Over 4,000 acres of previous new plantings were budgrafted.

More attention was devoted to the improvement of the processing of smallholders' rubber. An experimental project established at Kampong Sungei Marab Ulu was successful and group processing centres based on the experience obtained were established at a number of kampongs. At each centre members of a group use communal facilities and follow a uniform technique, but produce their sheet individually. The organisation required of the smallholders themselves is very simple and the system is proving popular.

Exhibits were provided at twelve Agricultural Shows during the year and the mobile film unit continued to show instructional films in the kampongs. At three of the major Agricultural Shows, smallholders' sheet making competitions were arranged. Publications of assistance to smallholders were issued in Malay, Chinese and English.

A survey of conditions on smallholdings for which the final replanting grant instalment had been paid was completed. It covered 1,097 smallholdings totalling 5,274 acres of replanting. The information collected was analysed for the preparation of a brief report.

ESTATES ADVISORY SERVICE

Plans were completed for a new Estates Advisory Service, as recommended by the Blackman Committee. Mr L. R. Davidson, formerly Smallholders' Advisory Officer, took charge of the new service towards the end of the year; it will relieve the Soils, Botanical and Pathological Divisions of routine advisory work, and also expand the volume of advice, particularly to the growing number of moderate-sized estates. For the present, advice to estates on the processing of latex and dry rubber is provided by the Advisory Officers of the Chemical Division.

C. E. T. Mann
Director

Soils Division

Division A Officers of the Division on duty at the commencement of the year were Mr G. Owen (Head of Division), Dr G. A. Watson and Dr V. M. Shorrocks. The Head of Division went on home leave in June and returned in October. Two vacancies were filled by the appointment of Mr K. R. Middleton (Soils Chemist) and Mr J. Bolton (Agronomist); they reported for duty in October. The Division was then at full strength for the first time in many years. Dr G. A. Watson went on home leave in November.

Two Division B Officers (Mr K. Raman and Mr M. M. Guha) were on duty until September when Mr M. M. Guha proceeded to the United Kingdom for further studies. He was granted leave of absence for 3 years to study for the Ph.D. degree at the Macaulay Institute for Soil Research, Aberdeen.

The following papers by members of the Soils Division were published in the *Journal of the Rubber Research Institute of Malaya*, Volume 15:

E. W. Bolle-Jones.	Foliar diagnosis of Mineral Status of *Hevea* in Relation to Bark Analysis.
E. W. Bolle-Jones and V. R. Mallikarjuneswara.	Cobalt: Effects on the Growth and Composition of *Hevea*.
E. W. Bolle-Jones.	Molybdenum: Effects on the Growth and Composition of *Hevea*.
E. W. Bolle-Jones.	Zinc: Effects on the Growth and Composition of *Hevea*.
G. A. Watson.	Nitrogen Fixation by *Centrosema pubescens*.
M. M. Guha and G. A. Watson.	Effects of Cover Plants on Soil Nutrient Status and on Growth of *Hevea*. 1. Laboratory Studies on the Mineralisation of Nitrogen in Different Soil Mixtures.

The following short articles prepared by members of the Division were published in the *Planters' Bulletin :*

Soil Inspection	*Planters' Bulletin*		*34*
Manuring Programme for Young Replantings	,,	,,	*35*
Cover Plants — a Discussion	,,	,,	*37*
Selective control of *Mikania* and Rubber Seedlings by Spraying	,,	,,	*38*
Leaf Sampling for Diagnosis of Nutrient Deficiency	,,	,,	*38*
Establishment and Maintenance of Legume Covers	,,	,,	*39*
Rooting Habit	,,	,,	*39*

RESEARCH

MANURING OF HEVEA

There were 54 field manuring experiments in progress at the beginning of the year, 43 on estates in different parts of the country and 11 at the Experiment Station. These experiments included 33 in mature rubber areas where records

of yields and girths were obtained and the remainder were in immature areas where only growth measurements (height or girth) were recorded.

Twelve experiments were terminated during the year, 8 in mature and 4 in immature areas. Of the 8 experiments in mature areas, 7 of them had been in progress since before the war and the trees in these areas were twenty or more years old. Eighteen of the experiments commenced in the period 1935 to 1941 are still in progress but the majority of these will be discontinued in 1959. Plans are made for commencing a number of new experiments in younger areas.

Eight new manuring experiments were commenced during the year, two of which include treatments with trace elements. Three are factorial 3 × 3 × 3 NPK experiments; in two of these the effects of fertilisers on growth and yield and on the mineral composition of leaves and latex are being studied.

Leaves and latex are sampled for a similar purpose in experiments involving treatments with trace elements and in another factorial NPK experiment begun in 1953. Experiments in progress at the end of the year include the following:

Manuring experiments, mature rubber:	(a) on estates	24
	(b) on the R.R.I. Experiment Station	6
Manuring experiments, immature rubber:	(a) on estates	5
	(b) on the R.R.I. Experiment Station	5
Experiments involving cover crop and fertiliser treatments:	(a) on estates	8
	(b) on the R.R.I. Experiment Station	2
		50

Effect of Fertilisers on Growth

Growth measurements recorded in twenty-six manuring experiments were analysed statistically during the year. Results continue to show beneficial effects on growth due to applications of nitrogen (9 trials) and phosphate (6 trials) but a positive response to potash was established with confidence in only one experiment. Results from three other field trials showed a depressive effect due to potash application. No important interaction effects were detected. The interaction between nitrogen and phosphorus was positive in one area on a light sandy soil and negative in a young replanting on heavy coastal alluvial clay soil. A negative nitrogen and potassium interaction was established in one area, again on coastal alluvial soil, and a negative phosphorus and potassium interaction in another area of old rubber on inland soil.

Growth measurements in the younger immature areas show a marked response to nitrogen. In a new planting on land cleared from jungle where the effects of different frequencies of application of N, P and K (nil, 4-monthly and 2-monthly applications) were compared, a response to nitrogen in terms of increased height was measurable at 3 months and was highly significant at 12 months after planting. The effect increased with increasing frequency of application in the range examined. At 12 months after planting, the mean height of plants receiving nitrogen applications at 2-monthly intervals was 8 inches greater than that of plants receiving no nitrogen. The effect of nitrogen was predominantly linear. Treatment with phosphate was beneficial in the same area, detectable at 9 months and highly significant at 12 months after planting. Applications of potash, however, depressed growth

markedly in the first year. Growth retardation was noticeable at 6 months after planting and the same effect was established with confidence when height measurements were recorded again at 9 and 12 months after planting.

A similar depressive effect of potash on growth was observed in two other trials on inland soils, suggesting that care is necessary to avoid using fertiliser mixtures with a high proportion of potash, particularly in the younger rubber areas. Current recommendations provide for applications of mixtures having a low potash content, except when there is evidence that potash deficiency may be an important limiting factor.

More evidence has been obtained of a response to fertiliser treatment in rubber areas on coastal alluvial soils. In two trials in replantings on heavy coastal alluvial clay loam a beneficial effect due to treatment with sulphate of ammonia was established—judged in terms of height measurements at 5 and 9 months after planting. In the experiment where the fertilisers were applied at varying levels the beneficial effect of nitrogen increased with increasing levels of application. There was no response to treatment with phosphate and potash or to trace elements (supplied as Sustanum Trace Element Mixture) in either of these two trials.

In a jungle clearing on light sandy soil planted in 1955 there was a marked response to increasing frequency of application of a fertiliser mixture supplying N, P and K (Mixture M). The same effect has been established in this area each year since planting. No benefit was obtained in this particular experiment either from compost mixed with the soil in the basket or from cow dung mixed with the soil in the planting hole before planting.

Observations on the effect of applications of magnesium limestone on growth were made in only one experiment during the year. It was established that treatment with magnesium in an area of twenty-year old budded rubber, which previously showed symptoms of magnesium deficiency, was beneficial; the effect, in terms of girth increment, increased with increasing levels of application up to 3 lb of magnesium limestone per tree.

In field trials involving treatment with micro-nutrient elements (manganese, copper and molybdenum), no effect on growth was detectable in the first year after treatment.

Effect of Fertilisers on Yield

Annual yield records from 24 manuring experiments were analysed during the year. In most of these trials the fertiliser treatments provided for three biennial applications commencing at varying times in the period 1948 to 1951 while the yield records discussed here are those recorded in 1957 and 1958. Results from 14 out of the 24 trials show responses to fertiliser treatment. Nitrogen had a beneficial effect on yield in four trials, phosphate in nine trials. A positive response was indicated in one potash trial and a negative response was established in another. Results from two trials showed a positive nitrogen and potash interaction but otherwise there were no important interaction effects. The pattern of effects is much the same as in previous years, showing increased yields due to treatment with nitrogen and phosphate with an indication that the effect of nitrogen is enhanced when potash is added. In areas where the fertilisers were applied at different levels the effects of both nitrogen and phosphate were predominantly linear. Again no difference was observed between the effects on yield of super-

phosphate and rock phosphate nor between those of broadcast and pocket methods of application.

Observations on the effect of applications of magnesium on yield were made in only one experiment. In this area the trees showed marked symptoms of magnesium deficiency in 1950 and ground magnesium limestone was applied at two different levels (1½ and 3 lb per tree) in 1951, 1953 and 1955. Yield records in the period 1957–1958 showed that the treatment had a beneficial effect which was greater at the higher level of application.

Effect of Fertilisers on Seed Production

Rubber seed collections were made in four manurial experiments, three of which are sited on inland soil types and the fourth on coastal alluvial clay. Statistical analysis of the data from one of the experiments on inland soils showed that seed fall was significantly increased by applications of rock phosphate and that some increase resulted also from treatment with nitrogen. Applications of potash tended to depress seed production in this area. No effects were established in the other three areas, but this is not surprising since fertiliser treatments in two of the experiments started only in 1957 and the third experiment commenced in 1958.

CULTIVATION AND GROUND COVERS

Weed Eradication

In experimental work on weed control carried out during the year emphasis has been placed on eradication of grasses by the use of herbicides. The chemical weedkillers tested in small scale trials include dalapon (sodium salt of 2,2-dichloropropionic acid), aminotriazole (3-amino-1,2,4-triazole), Monuron (3-(p-chlorophenyl)-1,-1-dimethylurea), diuron (3-(3,4-dichlorophenyl)-1,-1 dimethyl urea), neburon (1-n-butyl-3-(3,4-dichlorophenyl)-1-methyl urea), lallicide (sodium salt of trichloroacetic acid), pentachlorophenol, sodium chlorate and four new herbicides ACP-M-616, ACP-M-617, Simazine and Atrazine.

Lalang. Dalapon continued to give the best results for control of both lalang (*Imperata cylindrica*) and most of the smaller grasses. It was confirmed that lalang can be successfully eradicated by one round of spraying with dalapon at the rate of 15 lb in 100 gallons of water per acre, followed later by routine control of sporadic growth by wiping with oil.

Routine control of grasses and herbaceous weeds. The main purpose for which weedkillers are now used on the larger estates is for routine control of grasses and other herbaceous growths. Sodium arsenite is currently used for this purpose and the main objective has been to find a suitable substitute for this poisonous material. Good results have been obtained with dalapon but it is not completely satisfactory. Applied at the rate of 10 lb per acre it kills most of the smaller grasses and is particularly effective for control of *Axonopus compressus* which is the dominant grass in most rubber areas. But *Paspalum conjugatum,* which frequently occurs as an important component of a mixed population of grasses, is resistant to dalapon.

Aminotriazole, applied at the rate of 10 lb in 100 gallons of water per acre, gives useful control of *P. conjugatum* but has little effect on *A. compressus* even when applied at the rate of 15 lb per acre. Mixtures of dalapon and aminotria-

zole in varying proportions in the range 2.5 to 7.5 lb of each have been tested, but the results indicate that applications of a 50: 50 mixture at the rate of 15 lb per acre are required for effective control of the two grasses mentioned. When less than 7.5 lb per acre of either herbicide is applied results vary according to the relative proportion of the two grasses in the area treated, i.e. 7.5 lb per acre is the minimum rate of application of dalapon or aminotriazole for effective control of *A. compressus* and *P. conjugatum* respectively.

The effects of both dalapon and aminotriazole are more persistent than the effects of sodium arsenite, sodium chlorate or lallicide. An area colonised mainly by *A. compressus* can be kept reasonably clear of grasses, provided *P. conjugatum* is absent, by spraying with dalapon once every six months. The effect of aminotriazole on *P. conjugatum* persists just as long, or even longer, but colonisation by other grasses, e.g. *Digitaria marginata,* occurs rather more rapidly. Areas sprayed with either dalapon or aminotriazole are quickly colonised by broad leafed species of weeds such as *Mikania scandens, Ageratum conyzoides, Borreria latifolia, Croton hirtus,* etc. Thus even though grasses can be effectively controlled by spraying with dalapon or aminotriazole at intervals of about six months, further spraying with other weedkillers becomes necessary to control other herbaceous growths.

The effects of dalapon (10 lb per acre) and of aminotriazole (5, 10 and 15 lb per acre) were not improved by spraying with Neburon at the rate of 2 lb per acre two weeks later.

Diuron applied at the rate of 2 and 4 lb per acre gave useful control of *P. conjugatum* in a nursery but was less effective than aminotriazole applied at the rates of 7.5 and 10 lb per acre. Monuron and Neburon at 2 and 4 lb per acre were ineffective.

A small scale trial was carried out to compare aminotriazole with mixtures of aminotriazole and pentachlorophenol. None of the treatments was effective on *A. compressus,* while the effects on *P. conjugatum* varied according to the concentration of aminotriazole rather than that of pentachlorophenol. Solutions containing the equivalent of 2.5 and 5 lb of aminotriazole, each with 2.5 and 5 gallons of pentachlorophenol in 100 gallons, were relatively ineffective compared with aminotriazole applied at the rate of 10 lb in 100 gallons per acre. Mixtures containing the equivalent of 7.5 lb aminotriazole with 2.5 and 5 gallons of pentachlorophenol gave better results and compared favourably with aminotriazole at 10 lb per acre. It was concluded that no substantial advantage was gained by the use of pentachlorophenol in mixtures with aminotriazole.

ACP-M-616 and ACP-M-617 are different formulations of 3-amino-1, 2,4-triazole. M-616 applied at the rates of 5, 7.5 and 10 lb per acre gave results very similar to those obtained with aminotriazole. The effects on *P. conjugatum,* measured at 4 months after spraying, were estimated to be 60, 75 and 90 % kill with applications at the rate of 5, 7.5 and 10 lb respectively, whereas the effect on *A. compressus* was less than 10% kill with all three levels. In the same trials scores of the same order were recorded for aminotriazole at the same levels of application.

M-617 applied at the rates of 10, 15 and 20 lb per acre gave more encouraging results. This formulation was again more effective on *P. conjugatum* than on *A. compressus* but applications at the rate of 15 and 20 lb per acre gave useful

control of the latter grass species with respective scores of 50 and 70 % kill at three months after treatment. Further trials with M-617 are in progress.

Simazine and Atrazine are new products recently received and have not yet been thoroughly tested. Preliminary results from the first trials indicate that Atrazine is more effective than Simazine. Applied at the rates of 5, 10, 15 and 20 lb per acre. Simazine had only a slight effect both on *P. conjugatum* and on *A. compressus* (less than 10% kill), judged on observations made up to 5 weeks after spraying. Atrazine applied on *Axonopus compressus* at the rate of 20 lb per acre gave promising results with a score of 20% kill at 2 weeks and 80% at 5 weeks after treatment. With the lower levels of application (5, 10 and 15 lb) the scores at 5 weeks were 10, 20 and 45 % respectively. Atrazine/dalapon and Simazine/dalapon mixtures (5+5 lb per acre) were less effective than a mixture of dalapon with aminotriazole, judged on observations up to 5 weeks after spraying.

Strip spraying. In a small scale trial to test possible alternatives to sodium arsenite for routine control of weeds along rubber planting rows (strip spraying) best results were obtained with sodium chlorate applied at the rate of 20 lb in 100 gallons per acre sprayed at two-monthly intervals. *Paspalum conjugatum* was the dominant grass in this area and dalapon (2.5, 5, 7.5 and 10 lb) was ineffective. Lallicide (15 and 20 lb) was only slightly better while aminotriazole (5, 7.5 and 10 lb) gave appreciably better results. One application at the rate of 10 lb per acre completely suppressed grasses with little or no recovery up to 7 months after treatment but the sprayed strips were quickly invaded by the legume creepers and *Mikania scandens* from the inter-row areas. The strips were also colonised by other broad-leafed herbaceous growths, mainly *Ageratum conyzoides* and *Croton hirtus*. It was evident that clean-weeded strips along planting rows cannot be maintained satisfactorily and economically by spraying with dalapon or aminotriazole (depending on whether *Paspalum conjugatum* or *Axonopus compressus* is dominant) without the addition of another weedkiller to suppress or eliminate broadleafed weed species.

Tolerance of young rubber to weedkillers. Trials were carried out in a nursery to determine the tolerance of young rubber to the weedkillers under consideration for routine control of weeds along planting rows in replantings and new plantings. No harmful effects on young rubber plants were observed when dalapon and aminotriazole were applied at different rates up to 10 lb per acre. Monuron, Diuron and Neburon had no undesirable effects when used in concentrations up to 4 lb in 100 gallons per acre.

Bracken. In the *Annual Report 1957* it is reported that bracken *(Gleichenia linearis)* was effectively killed by spraying once with dalapon and with aminotriazole applied at the rate of 20 lb in 100 gallons per acre. Further trials carried out in 1958 showed that single applications at 10 and 15 lb per acre gave poor control while Fernoxone (the sodium salt of 2,4-D) at 5 lb per acre was also relatively ineffective. Bracken was killed by spraying with a solution of Floroxone (mixed esters of 2,4-D and 2,4,5-T) containing 4 pints of the concentrate in 100 gallons of water. There was little or no recovery up to six months after treatment.

Mikania scandens. The results obtained in large scale trials confirmed earlier observations in small scale experiments that *M. scandens* can be selectively controlled by spraying with a solution containing 1 lb Fernoxone in 100 gallons of

water. Other, more desirable growths, such as legume creepers and bushes, suffer a slight set-back but recover within about one month after spraying. Re-invasion by *M. scandens* can be prevented by spot spraying with the same strength solution (0.1%) of Fernoxone about six months after the initial spraying treatment.

Self-sown rubber. The possibility of selectively controlling the growth of self-sown rubber seedlings in a mixed cover of upright indigenous growth under mature rubber was examined. Observations made in a small scale trial indicate that this can be done by spraying with a solution containing half a pint of Floroxone in 100 gallons of water. The majority of the indigenous growths are not affected but the rubber seedlings suffer defoliation followed by dieback of the upper part of the stems; they thus receive a severe setback while the other plants are allowed to develop more strongly. It was judged that spraying at intervals of six months or longer gives effective control of the rubber seedlings.

Ground Covers

In the four experiments (factorial 2 × 2 × 2 NPK) designed to compare direct manuring of the rubber with indirect manuring via the ground cover of leguminous creepers, no effect of fertiliser treatment on the growth of the rubber was detected in the two areas on coastal alluvial clay soils in the first twelve months of the post-treatment period. A depressive effect due to potash was recorded in one of the experiments on inland soils, but no effects due to nitrogen or phosphate, whether applied to the ground covers or to the rubber, were established.

The experiments started in 1957, comparing different types of ground covers including mixed leguminous creepers (*Pueraria phaseoloides, Centrosema pubescens* and *Calopogonium muconoides*), *Mikania scandens,* grasses and mixed upright indigenous growths, have been continued. Analysis of height measurements of the rubber seedlings recorded in the first year after planting show no significant differences due to the covers.

Further evidence was obtained during the year that rate of growth of rubber growing in association with a ground cover of legume creepers is greater when the cover is controlled by strip weeding than when it is controlled by circle weeding, judged on height and girth measurements recorded up to two years after budding.

Nutrition of Leguminous Ground Covers

A pot experiment was carried out to determine which of the three legume creepers, *Centrosema pubescens, Calopogonium muconoides* and *Pueraria phaseoloides* is most suitable for use as an indicator plant in pot culture tests to assess nutrient status of soils. *P. Phaseoloides* proved to be the most suitable in that it produced the greatest dry weight of leaf, stem, roots and nodules in a given time and contained the highest levels of Ca, Mg, K, Mo, Zn and Cu in the tissues, thus exerting a greater stress than the other two legumes on the soil nutrient reserves. Other observations made in this experiment were that much higher levels of molybdenum were found in the stems than in the laminae of the three legumes and that *C. pubescens* and *C. muconoides* contained higher levels of manganese in the leaves than in the stems, whereas *P. phaseoloides* contained relatively high levels (up to 500 p.p.m.) in the stems compared with about 50 p.p.m. in the laminae.

In a pot experiment designed to study the effects of applications of lime and sodium molybdate on growth and mineral status of *Pueraria phaseoloides* growing on four different soil types, results showed that application of lime in general increased the dry weight of plant material while sodium molybdate had no marked effect on growth. The application of sodium molybdate to the soil increased the molybdenum content of the plant and tended to depress the P, Mg and Mn contents of the plant in the absence, but not in the presence of applied lime. The molybdenum content was highest in plants grown on the coastal alluvial clay soil and chemical analysis confirmed that this soil had the highest molybdenum content. In untreated soils the stems of the plants contained lower levels of molybdenum than either the leaves or nodules, but this position was reserved when molybdenum uptake was increased by application of either lime or sodium molybdate.

Three small scale field trials were carried out to study the effect of inoculation and applications of sodium molybdate and rock phosphate on the growth of mixed legume creepers. There was no noticeable effect due to inoculation or to application of sodium molybdate, judged on visual observations during the first year of growth. In two of the areas sited on inland soils there was a marked response to rock phosphate applied at the rate of 1½ cwt per acre and still better response to an application at the rate of 3 cwt per acre.

The effect of gibberellic acid on the growth of creeping legume covers was studied in small scale field experiments. No major effect was observed, using solutions with concentrations of 1, 10 and 100 p.p.m. of the acid, except for an early stimulation in growth of *C. pubescens* which was not maintained. Gibberellic acid in general depressed nutrient uptake by *C. muconoides* and *P. phaseoloides* but had no significant effect on the nutrient status of *C. pubescens*.

SOIL INVESTIGATIONS

Nitrification Studies

Further tests studying the effect of temperature and moisture on the mineralisation of soil nitrogen confirmed that nitrification is inhibited at high temperatures comparable with those recorded at the surface of uncovered soil in the field. Both ammonification and nitrification rates were lower in soil held at a moisture content of one-sixth water-holding capacity than in soils with moisture contents of one-third and two-thirds water-holding capacity. There was no marked difference between the rates recorded at the two higher moisture contents.

Incubation studies on the decomposition of plant litter under ground covers of *Pueraria phaseoloides* and *Mikania scandens* showed that the nitrogen content of freshly fallen litter from the legume creeper will undergo rapid mineralisation when in contact with soil, but that its C/N ratio increases with time and becomes more resistant to change. The addition of calcium carbonate sufficient to raise the pH of the incubation mixture to about 6 increased the rate of mineralisation, thus confirming the results of previous work.

Post-treatment sampling of cover plant material and soils was carried out in a field experiment involving a comparison of legume creepers, *M. scandens* and grasses as ground cover. After approximately eighteen months' growth the legume creepers produced the greatest bulk of green material and litter, and the total nitrogen content of this material was appreciably higher than that of the other

two ground covers. Analysis of soil samples showed that the levels of total carbon, nitrogen and phosphate were highest in the soil under *M. scandens* and lowest in the soil under legume creepers. Incubation tests carried out on samples of surface soil (0-3 in.) showed that, initially and after 15 days incubation, the levels of nitrate nitrogen were highest in soil under legume creepers. After incubation for 30 days, however, the highest level of nitrate nitrogen was found in soil under *M. scandens*. The significance of these results will be discussed in a later report.

In a short term investigation to study the fluctuation of nitrate-and ammonium-nitrogen contents of the soil after the onset of rains following a period of comparatively severe drought, no marked trend in the variation of soil nitrogen content was observed.

Phosphate Studies

Time was devoted to testing methods for determining total, organic and inorganic soil phosphate and to developing a method suitable for studies on the mineralisation of soil organic phosphorus. Incubation over a period of four months of mixtures of soil, plant material and mineral phosphate produced no noticeable changes in the different soil phosphate fractions, although normal mineralisation of the nitrogen was recorded.

PLANT INVESTIGATIONS

Methods and Techniques

An investigation was made into the variations in leaf mineral content with position of the leaves on the tree. Relatively little variation was found. A leaf sampling procedure for branched trees was established whereby leaves from the same position in the crown and in the same stage of development are sampled. The procedure for sampling leaves of younger unbranched trees had been determined previously. A description of the sampling technique for branched and unbranched trees has been published in *Planters' Bulletin 4* as a guide to growers when sending leaf samples for diagnosis of nutrient deficiency.

With a view to studying the variations in the contents of organic compounds in rubber leaves under conditions of nutrient deficiency, a procedure was developed for identifying and estimating the contents of the different amino acids in leaf extracts, using the circular paper chromatographic technique.

Mineral Composition of Foliage and Latex of Trees in Production

The effects of applications of nitrogen (sulphate of ammonia), phosphorus (rock phosphate) and potassium (muriate of potash) on the mineral composition of leaves and latex have been studied, using samples obtained from three factorial $3 \times 3 \times 3$ NPK field experiments sited on inland soils. Chemical analysis of the latex was carried out by the Chemical Division.

In the first experiment (clone P.B. 86, 1948 replanting), sampling was done before and after the first application of fertilisers in 1958. Significant effects of sulphate of ammonia and of muriate of potash were observed three weeks after treatment; sulphate of ammonia (4 lb per tree) increased the nitrogen content of the leaves, and muriate of potash ($\frac{2}{3}$ lb per tree) increased the potassium content of both leaves and latex. These effects have been maintained over the first five months

after the fertiliser application. The nitrogen treatment reduced the calcium content of the leaves and increased the manganese content of the latex; these effects were observed at two out of the four samplings following fertiliser treatment. Rock phosphate at the rate of 1 and 2 lb per tree had very little effect on the mineral composition of either the leaves or the latex, judged on analysis of samples up to five months after fertilisers were applied—except that application at the higher level increased the calcium content of the leaves and the phosphorus content of the latex at three and twenty-one weeks respectively after application.

In the second experiment (clone Tjir 1, 1949 planting) the investigation was commenced after the first experimental fertiliser treatment. Five samplings were carried out before, and four samplings after the second fertiliser application. A residual effect of the first application of sulphate of ammonia in increasing the nitrogen content of the leaves was significant (at the 10% level) at the time of sampling seven months after the first fertiliser application, but not at the subsequent four samplings made before the second application. The nitrogen content of the leaves was again increased very soon (3–7 weeks) after the second application of sulphate of ammonia and the same effect was established at subsequent samplings up to six months after treatment. It would appear that the direct effect of treatment with sulphate of ammonia on the nitrogen status of the leaves persists for about six to seven months after manuring. Over the same period the nitrogen content of the latex was not increased by the second application of sulphate of ammonia. These observations on the nitrogen content of the leaves and latex suggest that nitrogen applied to the soil is very quickly absorbed and translocated to the leaves and that the translocation to the latex is a relatively slow process. Other observations noted were that application of sulphate of ammonia at the higher level (4 lb per tree) decreased the potassium content of the leaves and that application of muriate of potash increased the potassium and the phosphate contents of the latex. No important effects of the application of rock phosphate on the mineral composition of the leaves or the latex were observed in the period covered.

In the third experiment (clone RRIM 501, 1951 planting) the investigation was restricted to a study of the mineral composition of the leaves. Experimental manuring had been done for nearly four years before the first samples of leaves were collected. The variations in leaf nutrient content therefore represent the cumulative effect of five fertiliser applications. Over a six-month period four samplings were carried out, of which three were made before the sixth application of fertilisers in 1958.

It was established that applications of muriate of potash increased the potassium and reduced the magnesium content of the leaves. Applications of sulphate of ammonia reduced the potassium content, and applications of rock phosphate increased the phosphorus content of the leaves. All the above effects were observed on all four sampling occasions. Other effects noted on three sampling occasions were that the magnesium content of the leaves was reduced by treatment with sulphate of ammonia and that the calcium content was increased by treatment with rock phosphate.

Trace elements. An investigation to study the effects of trace element applications on the mineral composition of the leaves and latex is in progress. Material for analysis is obtained from three field experiments sited on light inland soils

involving treatments with manganese sulphate, copper sulphate and sodium molybdate. Statistical analysis of the data is not yet complete but a marked increase has been noted in the manganese content of the leaves, bark and bark scrap following applications of manganese sulphate to the soil (4 oz and 8 oz per tree). Only a small increase in the manganese content of the latex was recorded. No effects on the mineral composition of the leaves due to applications of sodium molybdate or copper sulphate were observed one month after treatment.

The study of the effects of fertiliser applications on the mineral composition of leaves and latex in all the above experiments is continuing.

Total Mineral Content of Whole Trees

A study of the total mineral content of whole trees, varying in age between 1 and 9 years, is in progress. All the trees sampled were growing on light sandy soils at the Experiment Station, Sungei Buloh. This study involved the digging out of the tap root and main lateral root system. It was observed that in the lighter soils the main lateral roots are not confined to the surface layer of soil but can develop at varying depths down to three feet below the surface. Three-year-old trees were found to have lateral roots twenty to thirty feet long while seven- and eight-year-old trees had tap roots eight feet long and lateral roots extending over a distance of well over thirty feet. Descriptive details and illustrations of the root systems excavated have been published in *Planters' Bulletin 39*. Chemical analysis of leaves, branches, stems and roots is in progress.

POT-SAND-CULTURE EXPERIMENTS

Effect of Micro-Nutrient Status on Growth, Mineral Composition and Rubber Formation

A pot experiment designed to study the effects of boron on the formation and distribution of rubber in *Hevea* seedlings is in progress. Data from the first sampling carried out four months after sowing indicate that boron deficiency is associated with a higher concentration of rubber in the leaves and a lower concentration in the roots. Over the same period boron deficiency did not cause any reduction in plant dry weight nor was the total rubber content of the seedlings reduced.

Study of the Relative Requirements of the Rubber Plant for Various Nutrient Elements at Different Stages of Growth

An investigation of the requirements of *Hevea* seedlings for nitrogen, phosphorus, magnesium and manganese was carried out. By withholding the supply of the four nutrient elements individually and by measuring the growth of the seedlings it was possible to determine the period during which the seedlings can grow satisfactorily solely on the reserves of these nutrients in the seed. The effects of the deficiencies on growth was reflected more sensitively by the growth of the leaves than by stem or root growth.

Visual inspection revealed no effects on growth during the first two months after planting the germinated seed. The first sampling was at zero plus 63 days when it was judged that differences due to treatment were beginning to appear. It was established then that leaf growth was retarded by nitrogen deficiency. A reduction

in rate of growth due to deficiencies of the other three elements was proven at the second sampling (zero plus 91 days). Thus the seedlings require an added supply of nitrogen before phosphorus, magnesium and manganese. Further sampling was done at 105 and 168 days. It was observed that in the early stages of growth, up to about three months after planting the germinated seed, the requirement for magnesium and manganese was greater than that for phosphorus. In the later stages however the requirement for phosphorus exceeded the requirement for either magnesium or manganese.

Nutrient Deficiency Symptoms in Legumes Used as Ground Covers

A study of the leaf symptoms shown by *Pueraria phaseoloides* when growing under nutrient deficiency conditions has been carried out. The mineral composition of plants exhibiting deficiency symptoms was determined.

Characteristic symptoms due to deficiencies of nitrogen, potassium, magnesium, calcium, sulphur, manganese, iron, boron, zinc, molybdenum and copper were produced and recorded. The symptoms were very similar to those shown by *Centrosema pubescens* when growing under similar conditions. The withholding of phosphorus from the nutrient supply caused a marked reduction in growth of *P. phaseoloides*, but no characteristic leaf symptoms were observed except that the leaves were very small and widely separated on the vines. The deficiency symptoms of iron and manganese were difficult to distinguish, as were those of calcium and potassium. It is considered that in practice it would be necessary to confirm a visual assessment of mineral deficiency in *P. phaseoloides* by chemical analysis.

A similar study is in progress to identify nutrient deficiency symptoms exhibited by *Calopogonium mucunoides*, the third legume creeper commonly used as ground cover in rubber areas, and to determine the effects of the deficiencies on growth and mineral composition of the plant. Characteristic symptoms due to deficiencies of nitrogen, potassium, magnesium, sulphur, iron, manganese, boron, zinc and copper have been observed and photographed. Whilst the withholding of phosphorus, calcium and molybdenum from the nutrient supply has retarded growth and has resulted in the appearance of leaf discoloration, no characteristic leaf deficiency symptoms have developed up to two and a half months after sowing.

ADVISORY

The statistics relating to advisory work carried out by the Division during the year are as follows:

Letters and Interviews

Advisory letters and reports despatched	671
Advisory visits to estates	103
Interviews at the Institute	129

Samples Examined and/or Analysed

Soil	33
Plant	79
Fertilisers	26
Others	19

There was an appreciable increase in the volume of advisory correspondence and requests for visits to estates. The number of advisory letters and reports despatched increased by 50% over the previous year while the number of visits to estates increased from 61 to 103. The general pattern of advisory work was much the same as in previous years and there were no important new developments. Manuring continued to be the subject with the greatest number of enquiries in correspondence and accounted for 41% of the number of letters and reports despatched. It was also the subject most frequently brought up for discussion in interviews at the Institute. A greater appreciation of the importance of recognising deficiency symptoms in the field was noted, indicating a greater appreciation of the possible need for addition of nutrients other than nitrogen, phosphorus and potassium in certain areas. Magnesium deficiency is widespread and fertiliser mixtures containing magnesium are increasingly used. Several more areas showing clear symptoms of manganese deficiency were found during the year, notably in South Johore where marked symptoms of the deficiency were observed in both young and mature rubber areas covering quite large areas on some estates. The same deficiency, but less acute, has been observed in rubber areas in Selangor and Perak. It would seem that manganese deficiency may be an important problem locally. Experiments are in progress to determine the effect of applications of manganese sulphate on growth and yield of rubber in deficient areas; samples of leaves, bark, bark scrap and latex have been analysed. Results show that manganese applied to the soil is readily absorbed by the trees and it appears that applications of manganese sulphate at the rate of 4 oz per tree may be adequate to correct the deficiency in mature rubber areas. Further experiments are required to determine the optimum rate and frequency of application for trees of different ages.

Reports on examination and/or analysis of rubber leaf samples accounted for 12% of the advisory letters despatched. As in previous years, the majority of samples sent for examination showed symptoms of magnesium deficiency but in samples received towards the end of the year manganese deficiency was the cause of nutritional disorder most frequently observed. Analysis of several other samples showed a deficiency of potassium. It would appear that planters are getting more and more familiar with symptoms of magnesium deficiency which are easily recognisable but the symptoms of potassium deficiency are not so well known nor so easily detected. Judging from observations made in the course of visits to estates, a sub-acute deficiency of this nutrient element is widespread in rubber areas on inland soils but is largely restricted to mature rubber areas. A few of the samples received showed a type of marginal necrosis associated with waterlogging and the remainder were samples collected from problem areas where nutritional disorder was suspected but not confirmed.

Several enquiries were received concerning the use of urea and new ready-made NPK fertiliser mixtures introduced from abroad. Experiments are in progress to compare the latter with the standard mixtures prepared locally and most commonly used for the manuring of rubber in Malaya.

Weed control was again the subject of several enquiries accounting for 11% of the number of letters despatched while advice on cover crops accounted for 8% of the advisory correspondence. Enquiries on weed control were mainly in connection with eradication of the more uncommon weeds and particularly those which are resistant to sodium arsenite. This weed killer is still used extensively

for routine control of weeds on estates and only a few enquiries concerning suitable alternatives were received. However, the urgent need for a suitable alternative to replace sodium arsenite for this specific purpose is appreciated and the problem of finding a reasonably inexpensive and effective herbicide or mixture of herbicides that can be used for control of a mixed population of weeds figures largely in experimental work.

Few enquiries were received on replanting problems other than manuring. Several soil samples were sent with a request to assess suitability for planting or replanting. Fertilisers and other miscellaneous samples were received with a request for analysis. Advice was sought on lay-out of experiments and one estate sent in growth measurements for statistical analysis and comments on the results. Interest in mechanical cultivation appears to be waning, judging from the number of enquiries received, although the subject was brought up a few times in discussions on estates and at the Institute.

A new feature in the advisory work was the number of requests for advice concerning the suitability of land for rubber planting in large scale State-organised land settlement schemes. Visits were made to twelve large areas under consideration for Land Development Schemes in company with the Smallholders' Advisory Officer, District Officers and State Agricultural Officers and, on two occasions, in company with a member of the Soils Division of the Department of Agriculture. These visits involved inspection of several thousands of acres and our advice was required to supplement more detailed survey of the soils by the Department of Agriculture.

The Soils Chemist (Dr G. A. Watson) gave a lecture on soil nutrient deficiencies to the Port Dickson branch of the Incorporated Society of Planters and gave talks on soil topics to Senior Estate Conductors and Trainees for posts as Rubber Instructors attending courses of instruction at the R.R.I. Experiment Station. The usual assistance was given to the Technical Education Scheme of the Incorporated Society of Planters by setting questions and marking papers for the Soils Section of the Agricultural Science Examinations held in February and August.

G. Owen
Head of Soils Division

Botanical Division

The Head of the Division (Mr C. W. Brookson), Dr P. R. Wycherley, Dr S. G. Boatman and Mr T. V. Vaidyanathan were on duty throughout the year. Ir P. de Jonge returned from long leave on 23 January but was absent on medical leave from 13 March; he returned to Malaya on 25 May. Mr M. M. Chandapilla joined the Division on 2 January as a Research Officer Division B in charge of the Herbarium and to work on ecological problems. Dr J. K. Templeton joined the Division on 24 January as a Research Officer Division A to work on growth studies. Mr J. M. Ross was absent on home leave and study leave during the first half of the year; he reported for duty on 6 August. Ir E. C. Paardekooper joined the Division on 23 August as Research Officer Division A in charge of the variety trials on estates. Mr P. D. Abraham joined the Division on 13 October as a Research Officer Division B and was posted to the Experiment Station to assist Dr S. G. Boatman in yield stimulation experiments and screening of growth substances. Mr R. J. Garner, Chief of the Division of Pomology of the East Malling Research Station, Kent, England, came to the Rubber Research Institute to carry out investigations on vegetative propagation of *Hevea* for a period of four months commencing 1 September. He left Malaya on 29 December. Mr G. H. Tinley joined the Division on 26 November as a Research Officer Division A and was stationed on the Experiment Station to continue the work on vegetative propagation of *Hevea* initiated by Mr R. J. Garner.

Mr P. Balasubramaniam was appointed laboratory assistant; he reported for duty on 10 March, and was confirmed in his appointment. Mr P. G. Davis, clerk-typist, on scale P.C., was transferred to work with the staff of the Botanical Division on the Experiment Station on 1 July. Mr A. Vinayagam was appointed in his stead and reported for duty at Headquarters on 1 July. Mr V. Srinivasan was appointed to replace Mr N. P. Vellasamy as laboratory attendant on 3 December.

Research Officers made fifty-seven visits to estates in connection with research work of the Division; some advisory work was included in most of these visits.

Ir P. de Jonge, during his special leave in Europe, visited East Malling Research Station and discussed vegetative propagation with the Director, Dr F. R. Tubbs, and Mr R. J. Garner. Mr J. M. Ross attended a four-months course of study in plant breeding and cytology at the John Innes Horticultural Institute. We are indebted to Dr K. S. Dodds, a member of the Blackman Committee and Director of the John Innes Institute, who kindly arranged this course of study for Mr Ross. Dr P. R. Wycherley attended part of the Darwin Wallace Centenary and Bicentenary Congress at the University of Malaya, Singapore in December 1958. At the invitation of the UNESCO South East Asia Science Cooperation Office he also participated in the Symposium on Vegetation of the Humid Tropics held at Tjiawji, Bogor, Indonesia. The opportunity was taken to visit the Kebun Raya (Botanic Gardens), the Centrale Proefstations Vereniging in Bogor, and also other places of interest in Java during his visit.

At the end of the year plans were in hand to provide further accommodation both at Kuala Lumpur and on the R.R.I. Experiment Station.

A tentative programme of new planting and replanting for experimental work has been drawn up for the next five years in consultation with the Director, the Head of Soils Division and the Manager of the R.R.I. Experiment Station. No reserve land is available at Sungei Buloh after 1959 for further expansion of the Station. Although it will be possible to lay out new experiments on replanted land we need new virgin land. Plans for the development of Substations, as recommended by the Blackman Committee, are to be further considered by the Board in 1959.

The following papers were published in the *Journal of the R.R.I.M.* Volume 15.

E. D. C. Baptiste.	Poisoning Experiments with *Hevea brasiliensis* I. Preliminary Trials—Destruction of Trees with 2,4-D and 2,4,5-T.
E. D. C. Baptiste and P. de Jonge.	Poisoning Experiments with *Hevea brasiliensis* II. Results of a Further Tree Poisoning Experiment with 2,4,5-T.

Document 10 of the *Research Archives of the Rubber Research Institute of Malaya* was completed during the year in two parts under the title of 'A Report of R.R.I.M. Large Scale Variety Trials of, *Hevea brasiliensis* (Muell-Arg) on Malayan Estates, 1934–1953' by H. M. Burkill.

A shortened version of this Document was prepared for publication in the *Journal* in 1959.

At the UNESCO Symposium on 'Humid Tropics Vegetation' at Bogor, Republic of Indonesia, Dr P. R. Wycherley presented the following papers: 'An Acre of Disturbed Forest' by P. R. Wycherley and V. K. Bhaskaran Nair and 'Notes on the Spread of *Croton hirtus*' by P. R. Wycherley. Mr J. M. Ross presented a paper at the *XV International Horticultural Congress* at Nice, Monaco, on 'The Introduction of New Material of *Hevea brasiliensis* to Commercial Planting.'

The following articles were prepared for *Planters' Bulletin* and published during the period under review:

Achieving an Optimum Stand	*Planters' Bulletin*		*34*
RRIM 600 Clones — Second Series	,,	,,	*34*
Ninth Pacific Science Congress — Editorial	,,	,,	*35*
Clones RRIM 600–618	,,	,,	*36*
Buddings and Clonal Seedlings	,,	,,	*36*
Planting Density — Editorial comment on correspondence	,,	,,	*37*
Intensive Tapping of Mature Rubber	,,	,,	*38*
Pretreatment of Leguminous Cover Crop Seeds	,,	,,	*39*

RESEARCH

BREEDING AND SELECTION

Hand Pollination

Seven thousand and eighty-eight hand pollinations were made during the main flowering season. There was a good set of fruit but adverse weather conditions caused considerable fall of the growing fruit in June. The percentage of pollination successes and the germination results were somewhat below average. There

is a field for further research on the physiology of flowering and seed formation in *Hevea.*

Of the nine families obtained, three are the results of crosses between clones imported in 1953 as resistant to *Dothidella ulei* and high yielding Eastern clones. One hundred and fourteen seedlings resulted from these three crosses, bringing the total of the F_1 progeny of crosses between clones resistant to *Dothidella* and Eastern clones at the Experiment Station to five hundred and forty-six.

No successes were obtained from the crosses GT 1 × LCB 1320 and LCB 1320 × RRIM 507. The percentage of seed germination ranged from 45.3 for the cross RRIM 623 × FX 25 to 86.0 for RRIM 501 selfed. The two hundred and four seedlings resulting from the programme were planted out in the Field 50 nursery. Pollen of the D.R. (*Dothidella*-resistant) clones FX 25 and FB 3365 was supplied to the Chemara Research Station for use in breeding work recently re-started by the Guthrie group.

The final results of the 1958 hand pollination programmes are set out in the Table below.

FINAL RESULTS OF HAND POLLINATION 1958

Family	No. of pollinations	No. of fruits harvested	% success	No. of seeds planted	No. of seeds germinated	% germination
1. LCB 1320 × FX 25	511	12	2.3	36	22	61.1
2. RRIM 623 (PB 49 × Pil B84) × FX 25	1101	39	3.5	117	53	45.3
3. LCB 1320 × RRIM 623 (PB 49 × Pil B84)	1505	26	1.7	78	46	60.0
4. GT 1 × RRIM 623 (PB 49 × Pil B84)	424	11	2.6	33	17	51.5
5. GT 1 × LCB 1320	499	—	—	—	—	—
6. RRIM 501 (Lun N × Pil A44) × FB 3363	1553	21	1.4	63	39	62.0
7. LCB 1320 × RRIM 614 (Tjir 1 × RRIM 509)	372	3	0.9	9	4	44.4
8. LCB 1320 × RRIM 607 (Tjir 1 × PB 49)	132	—	—	—	—	—
9. RRIM 501 selfed (Lun N × Pil A44)	991	9	0.9	27	23	86.0
Total	7088	121	1.7	363	204	56.2

Seedling Families

Seedling from the 1947 hand-pollination programme have now been tapped for over three years. It is clear that there is no outstanding family. The best is RRIM 507 (Pil B84 × Pil A44) × Tjir 1 which has given a mean yield over three years of 35 grams per tree per tapping compared with 25 grams per tree per tapping from the control, Tjir 1 illegitimate seedlings.

Seedlings from the 1948 hand-pollination programme completed the second year of tapping in June 1958. The highest yielding families over two years of tapping are 44/553 (Tjir 1 × Pil B84) × RRIM 501 (Pil A44 × Lun N), RRIM 623 (PB 49 × Pil B84) × RRIM 501 (Pil A44 × Lun N) and 33/520 (Tjir 1 × PB 24) × RRIM 501 (Pil A44 × Lun N) with respective mean yields of 51, 49 and 49 grams per tree per tapping compared with 20 grams per tree per tapping from the control, Tjir 1 illegitimate seedlings.

Seedlings from the 1949 hand-pollination programme completed the first year of tapping in March 1958. The highest yielding families were RRIM 610 (RRIM 504 × Tjir 1) × RRIM 500 (Pil B84 × Pil A44) and RRIM 83 × RRIM 509 (Pil A44 × Lun N) with yields of 32 and 26 grams per tree per tapping respectively, compared with 16 grams per tree per tapping from the control, Tjir 1 illegitimate seedlings.

Clones

A small scale trial of clones made from the 1956 hand-pollinated seedlings growing in Field 61A, R.R.I. Experiment Station, was budded in Field 61C in April and May. The design consists of three simple lattices giving two replications of each clone. The total number of clones is five hundred and seven.

Towards the end of the year preliminary selection for further testing of clones made from the 1948 hand-pollinated seedlings was started. The clones have been tapped for two years. The crosses which produce the highest proportion of promising clones are: 44/553 (Tjir 1 × Pil B84) × RRIM 501 (Pil A44 × Lun N); RRIM 632 (Tjir 1 × PB 49) × RRIM 500 (Pil B84 × Pil A44); 34/373 (RRIM 504 × RRIM 509) × RRIM 500 (Pil B84 × Pil A44); 33/520 (Tjir 1 × PB 24) × RRIM 500 (Pil B84 × Pil A44); 33/520 (Tjir 1 × PB 24) × RRIM 501 (Pil A44 × Lun N); RRIM 623 (PB 49 × Pil B84) × RRIM 501 (Pil A44 × Lun N); RRIM 600 (Tjir 1 × PB 86) × RRIM 500 (Pil B84 × Pil A44).

Cytology

By using a method of squashing root tips and staining with basic fuchsin, chromosomes have been counted in the roots of RRIM 501 illegitimate seedlings, and in clonal roots arising from buddings of PR 107. In both materials the diploid number of chromosomes was the normal thirty-six, i.e. $n = 36$.

Seed Storage

A small scale trial of coating fresh seed of *Hevea brasiliensis* with shellac, wax and latex concentrate indicated that there is little promise of such treatments prolonging the viability of the seed under normal storage conditions. Fresh seed untreated gave 60% germination; untreated seed failed to germinate after four and eight weeks storage. Treatment with shellac, wax and latex concentrate gave germinations following four weeks' storage of 1% (after opening the micropyle), 2% and 2%, respectively. No treated seeds germinated after eight weeks' storage.

Effect of Growth Substances on Seed Viability and Germination

A pilot experiment on seeds collected from untreated trees and from trees treated at six months intervals with proprietory 2,4-D yield-stimulating preparations

showed that the treatment used had no effect on the germination or the habit of the seed. No attempt was made to compare the amount of fruit set between the two treatments.

TRIALS OF SELECTED PLANTING MATERIAL ON ESTATES

Projected Trials

As a result of the preliminary selection noted in the 'clones' section above, up to ten clones will be available for trial in 1959.

Pre-war Trials

At the end of 1959 the number of trials was as follows:

NUMBERS OF PRE-WAR TRIALS

Type of trial	1 Jan. 1958	31 Dec. 1958	Expected 31 Dec. 1959
RRIM 500 series trials	9	9	8
Clonal seedling trials	6	2	—
Standard clones trials	3	3	—
Subsidiary clones trials	4	2	—
Total	22	16	8

It has been decided to discontinue all estate trials from which the maximum useful information has been obtained. Further records would not be commensurate with the expenditure and the recording work required from estates and Institute staffs.

During 1958 most of the RRIM 500 series clone trials were tapped on renewed bark. First results indicate that the yield of clone RRIM 501 on renewed bark does not drop to any appreciable extent, although the thickness of the renewed bark is below average in the majority of these trials.

Of the RRIM 500 Series Clones represented in the pre-1942 field trials on estates, RRIM 501, 513 and 519 maintain their leading positions in the trials in which they are represented. Of these clones, RRIM 501 gives the greatest early gains (c.f. post-war trials); the other two clones, especially RRIM 513, appear to be more satisfactory for sustained yields over the ten-year period now concluded—probably owing to their resistance to wind damage and good secondary characters.

Information on RRIM 526 is still limited, owing to losses of trials during war and the emergency. RRIM 527 continues to be withdrawn from the planting recommendations because of its bad wound response in tapping. Further observations suggest that this defect may be associated with a form of brown bast, and those who have planted RRIM 527 in the past are advised to employ third daily tapping and to report defects at once to the R.R.I.M.

Post-war Trials, Mature and Immature

The number of these trials are shown below:

NUMBERS OF POST-WAR TRIALS

Trials	In tapping for: 3 yrs or more	2 yrs or more	1 yr or more	less than 1 yr	Older than 5 years but not yet in tapping	Immature: 3-5 yrs	0-3 yrs	Total no. of trials
Distributed block trials (RRIM 600 series) — No. of blocks		3	16	15	5			
Distributed block trials (RRIM 600 series) — No. of estates		1	8	9	2			20
RRIM 500 series trials (complete)		1	1					2
RRIM 600 series trials (complete)	1	1	2	11	8	14*	3*	40
Exchange clones trials							6*	6
Clonal seedling trials							1	1
Total	1	3	11	20	10	14	10	69

* One 'observation' area included

RRIM Clones. The results of the second year of tapping of clones RRIM 600 to 618 in the first large scale trial in Field 48A on the R.R.I. Experiment Station were published in the *Planters' Bulletin 36*, 1958. The results of the first year of tapping of clones RRIM 619–630, R.R.I. Experiment Station, Field 48D, appear in *Planters' Bulletin 34*, 1958. The results of the third year of tapping of clones RRIM 619–630 will be published in *Planters' Bulletin 41* of March 1959.

Of clones RRIM 600–618 only RRIM 613 and 614 yielded more in the third year of tapping than RRIM 501, but in both clones about 30% of the trees were heavily damaged by wind. Their crown development and lack of trunk strength have caused anxiety in the estates trials and they have been dropped for the present from the list of promising experimental clones for planting.

Of clones RRIM 619–630, clone RRIM 628 gave the exceptionally high yield of 1,850 lb per acre. However, the performance of the clone will have to be confirmed in other trials before it can be added to the list of promising clones for small scale estate planting.

Clones RRIM 600, 603, 605, 607, 610 and 623 remain on the list for immediate small-scale planting and RRIM 606 has been added. The latter has surpassed RRIM 501 in cumulative yield over two years; it is vigorous and has good secondary characters including latex suitable for all forms of processing; a survey of all field trials in which it is present so far has relieved anxiety concerning susceptibility to wind damage.

This last feature of poor resistance to storm damage is receiving close attention, because wind losses often occur at a stage when the loss of yield cannot be economically corrected by replanting. For this reason the 'slow starters' such as RRIM 612 are not yet discarded.

Tapping in a 'hedge' planted trial, containing clones RRIM 619–630, started in July 1958. In the first six months RRIM 628 gave the highest yield per tree per tapping.

In two estate experiments forming part of the post-war RRIM 500-series trials in which the clone is included, the yield of PR 107 was very disappointing in the first year of tapping. RRIM 527 gave about the same yield as RRIM 501.

In one of the two RRIM 600 series trials which finished their first year of tapping, clones RRIM 527, 605 and 616 yielded better than RRIM 501 in grams per tree per tapping. In another trial, in tapping for six months, the highest yields per tree were obtained from RRIM 600, 605, 607, 610, 613, 614, PB 5/37 and PB 5/51.

Although it is questionable whether the original conception of the 'distributed block' trials (the statistical analysis of all these blocks to be made as part of one experimental design) can be followed up, many of these trial plots and blocks are giving valuable information at the moment. At the end of 1958 at least one year of tapping was concluded in 10 trials, representing 21 blocks. Two trial blocks had to be abandoned.

A complete review of the results of the estate trials up to 1958 is in preparation. Generally speaking the results of the Field 48A trial at the Experiment Station are confirmed, RRIM 605, 610, 614 and 501 being the highest yielding clones in the first year of tapping.

By the end of 1959, thirteen estate trials will have been in tapping for at least one year. Girth recording continued in all immature trials.

International exchange clones trials. Of the four 1954 exchange clones trials which are listed together (each one containing the same ninety-one clones) one was budded during 1958, while in the other three supplying was completed in December 1958. Girth measurements were taken in the two-years-old trial at the Experiment Station. An area containing seventy-two observation plots of the exchange clones was added to the list of estate clone trials.

Clonal seedlings. A 28-acre clonal seedling trial was planted, containing illegitimate seedlings of nine RRIM 600-series clones and RRIM 501 seedlings from various sources.

Recording

Arrangements were made to convert the system of recording in the younger trials to the punched card system, so that the 'Power Samas' machine can be used for the rapidly increasing volume of yield trial data and analysis of records.

An experiment was carried out to investigate the differences in moisture content of cup lumps of different size in connection with plans now in preparation for reorganisation of the procedure for yield recording in field trials.

With the impending installation of a new crepeing battery at the R.R.I. Experiment Station, considerable thought was given to improving recording by crepeing and drying cup-lump with a view to increasing accuracy and reducing delays between tapping and final recording and summarising of data. Provision was made in the estimates for 1959 for this purpose. The new proposals have been discussed with the Manager of the Experiment Station and final plans were prepared in connection with financial estimates for 1959.

PROPAGATION AND PLANTING TECHNIQUE

Vegetative Propagation of Hevea brasiliensis

The propagation of selected clones by bud-grafting on to unselected vigorous seedling-stocks has proved of great practical value but is not complete vegetative propagation because the rootstocks are non-clonal. The aim therefore is to propagate both the top and the root system of the grafted tree vegetatively. Judging by experiences with crop plants, deciduous fruits and other woody plants, this mode of propagation can provide excellent control of vigour, yield and many other features, enabling growers to increase the efficiency of their material by suitable combinations of scion and rootstock. Shoots and stems of young *Hevea* seedlings, taken below a height of about 4 feet from the collar, root comparatively readily but those made from the young scions of selected clones are extremely shy to root and success has only rarely been achieved.

Arrangements were made for Mr R. J. Garner of the Pomology Division of the East Malling Research Station to visit Malaya for a period of four months to initiate work on new methods of vegetative propagation. The object was to establish a method of propagation of clones by cuttings and to produce uniform clonal stock material. Five clones were treated in several ways to provide material for these experiments. A special nursery was made available. Propagation beds and a field laboratory were constructed.

Three main methods of vegetative propagation are now under test at the Experiment Station: namely cuttings, layers and grafting. Cuttings are regarded as the most promising and important because, if successful, they would be the most susceptible of large scale exploitation. Various kinds of cuttings have been tried, both leafy and leafless (hardwood), collected from nursery trees which have been prepared in various ways, for instance after pruning. These are set in beds where different treatments such as shade, mist sprays, media of differing properties and nutritive treatments can be applied.

Layering methods involving etiolation of young shoots are under test and wide use is being made of a number of marcot (air layering) techniques.

Although budgrafting remains practically the only means of joining scions and rootstocks of *Hevea*, other techniques are being tried. The exudation of latex at cut surfaces has been a problem but the technical difficulties of grafting may be overcome.

This work on propagation methods was begun in September 1958, and some preliminary experiments have been completed. Rooting of clones has been achieved on a small scale but the more valuable aspect of the work at this stage is the indication of profitable lines of attack, which will be directed towards an examination of the rooting propensities of desirable clones in relation to source and season.

To summarise the position at the end of the year a start has been made in re-opening enquiry into the practical possibility of propagating mature clones of *Hevea* vegetatively by cuttings, layers and, possibly root/shoot grafting. Propagation of plants by cuttings is generally found to be more practical than by layering, but *Hevea* presents many problems to the propagator. The most promising methods so far involve severe wounding of young leafy shoots intended for cuttings, not only knife edging the bark as described by Levandowsky (Agricultural Division, U.S. Operations Mission to Viet-Nam. Nov. 1958) but also much more severely,

to include a considerable proportion of the wood, combined with hormonal treatments and the exclusion of light from the vicinity of the wound.

Work with marcots suggests that the nature of the wounding treatment is important. The use of marcots using traditional methods based on cow-dung and clay may cause young shoots to die. Moist coir dust in polythene lay-flat tubing proved more satisfactory.

There are indications that, clonal roots being available, it will be possible to graft small pieces of these to the bases of cuttings and marcots (see below) to assist the rapid establishment of self-rooted plants.

Vegetative Propagation by Large Marcots

Prior to suggestions that Mr Garner should visit Malaya certain work was done on the subject with the following results.

A combination of top working with a bud from a young seedling and marcotting (see *Appendix*) was successful in producing roots on PR 107 buddings at the pole stage of growth. Roots have now been obtained on plants of fourteen clones by this method. However, in eight clones marcotting alone was sufficient to induce rooting. The quantity of material investigated by the close of the year was inadequate to determine whether or not the influence of the seedling shoot assists certain clones to produce their own roots. It has been demonstrated that this influence is unnecessary for some clones. This point is receiving continued study.

The roots produced by this method have been used for cytological study and shoot/root grafting experiments. The material is destined for an investigation into possible clonal variation in susceptibility to root diseases and for a preliminary stock/scion trial.

Crown Budding

The established crown budding experiment continues to show a marked influence of the nature of the crown on the girth increment of the trunk. The crown budding of a further trial employing disease resistant clones was in progress at the close of the year.

Stock/Scion Experiment

Analysis of stock/scion experiments has not revealed additional information to that given in the *Annual Report 1957*. The promising results obtained with propagation of known clones as cuttings or marcots make it likely that a new stock/scion experiment can be established in which the stock material will be uniform in its genetical make-up.

The first year of tapping in the experiment in which *Hevea spruceana* and *Hevea brasiliensis* are compared as stocks for budding, has been completed, but the results have not yet been statistically analysed.

TAPPING

Full Spiral Tapping

The results of all experiments have been analysed.

Four large scale experiments were set up in 1947/1948 on clones Pil B84, Pil D65, PB 186, PB 86, BD 5, Tjir 1, Tjir 16 and Glenshiel 1, in which full spiral

fourth daily tapping (C/1.d/4.100%) was compared with half spiral alternate daily tapping (S/2.D/2.100%). One experiment had to be discarded owing to bandit activities.

Over a period of eleven years of tapping, half spiral alternate daily tapping has yielded more than full spiral fourth daily tapping on all clones, except clone Pil D65 in one experiment. Girthing was better following half spiral alternate daily tapping in all experiments. Clone Glenshiel 1 was very adversely affected by full spiral tapping. The renewed bark is significantly thicker on trees tapped on a full spiral cut in all experiments, probably due to a semi-girdling effect resulting in accumulation of food substances above the full spiral cut, which also explains the bottle shape of trees so tapped. The trees tapped on full circumference (spiral cuts) also yielded a larger amount of lower grade rubber on account of the universal tendency towards a lengthy flow period when trees are tapped in this way.

Further experiments have been carried out in an effort to overcome the disadvantages of full circumference tapping while maintaining the economic advantages of the system.

Periodic full spiral systems of various intensities, and also continuous full spiral tapping at intervals of four, five and six days have been investigated in a range of experiments. The most promising tapping systems tried out are the full spiral third daily periodic systems of 100% tapping intensity, which in one experiment gave a yield similar to that of the control s/2.d./2.100% system over a period of 7 years, without inducing a depressing effect on girthing. However, in another experiment carried out on old budded trees s/1.d/3.9m/12.100% showed no advantages over s/2.d/4.100% tapping.

Tapping Experiments on Planting Material Sensitive to Brown Bast

One experiment on clone Glenshiel 1 has been discontinued during the year under review. It has shown that under the conditions of the experiment third daily tapping of a half spiral cut keeps the dry-tree incidence low and gives yields similar to those obtained by alternate daily tapping of a half spiral cut in the fourth year of tapping. This confirms our tapping recommendations for this clone.

Another experiment is in progress on Prang Besar 'Further Proof' Clonal Seedlings. The third year of tapping is nearly completed and the alternate-daily tapped tasks yield approximately 20% higher than the third-daily tapped tasks, without showing a poorer rate of girthing, which is at the rate of $2\frac{1}{2}$ inches per year for trees tapped from the start of the experiment. The yield level of the experimental area is high, over 1,000 lb per acre in the second year on alternate daily tapping. It showed no appreciable drop when the cuts were changed over to the second panel at a height of 40 inches from the ground. Six tasks were treated with a yield stimulant in an effort to obtain still higher yields and to find whether this would influence the brown bast incidence. Only a small gain in crop was achieved (mainly collected as lower grades) and girthing was significantly retarded. A high dry-tree incidence was observed some eighteen months after application of the stimulant. No second application was given. The tasks which were treated with a stimulant are now tapped daily for fifteen days followed by fifteen days rest. The trees are girthing normally in the second and third year of tapping.

The changeover system $s/2.d/2.2 \times \frac{12m.100\%}{24}$ has kept the brown bast incidence low during the first two years of tapping, but appears to have a slightly depressing effect on girthing.

High or Ladder Tapping

Information on these experiments has been published in *Planters' Bulletin 38* (September 1958) in the article 'Intensive Tapping of Mature Rubber.' Other experiments carried out on co-operating estates show that the yield from high cuts of young trees is considerably less than the yield from low cuts and also that budded trees yield more on good bark of first renewal than on high cuts in the virgin bark. It therefore appears that ladder tapping should be done at the later stage of life of rubber trees, when virgin and first renewal bark have been tapped away, that is after some 20–24 years of half spiral alternate daily tapping, or in the case of seedlings after an even longer period of third daily tapping.

Intensive Tapping

Full information on these experiments has been published in the article in *Planters' Bulletin 38,* mentioned above.

A further experiment is being carried out on high yielding mixed buddings of eighteen years of age, in which alternate daily and third daily tapped single and double cut tapping systems are compared. The results of the first experimental year show that the third daily tapped systems gave a superior response to stimulants. Another interesting observation is that third daily tapped trees react by a greater depression in yield to wintering and dry periods than alternate daily tapped trees. This observation has since been confirmed in other experiments.

Interaction between Tapping, Stimulation and Manuring

Two experiments are in progress of which one has completed the first year of tapping. A small stimulating effect was recorded after the first application of a yield stimulant. No differences in girthing can yet be established between treatments. The second experiment is carried out in co-operation with the research unit of a leading rubber company in which three tapping systems are compared at four levels of manuring on budded trees of clone PB 86. The systems compared are s/2.d/2.100%; s/2.d./3.67% and 2s/2.d/3.133%. The double cut system was opened at 60 and 30 inches from the union and tapping is done on different days. After a period of tapping using the experimental systems, the manuring programme was put into effect. The results to date show that the double cut system severely retarded growth. No data are yet available on the effect of manuring.

PHYSIOLOGY AND MORPHOLOGY

Yield Stimulation

Two long term experiments continue, one on clonal seedlings and one on buddings of nine clones. In the former, new tapping cuts have been opened in bark of second renewal stimulated in 1952. There are not yet sufficient data to comment on the effect of stimulant application on this bark, but the yield is satisfactory. The bark is significantly thicker than that of the control trees. There has been close co-operation with estates carrying out yield stimulation experiments during the year under review.

Field Screening Tests of Plant Growth Substances

Two large field experiments were set up in Field 25(V) at the R.R.I. Experiment Station at the end of 1957 to screen compounds supplied by Professor G. E. Blackman. In the first experiment a number of chlorine-and fluorine-substituted phenoxyacetic acids were compared. From the results of this experiment and those of the earlier test in Field 46 it is evident that certain of the fluorophenoxyacetic acids are highly active yield stimulants. In the second experiment several chlorobenzoic acids were also shown to have promising activity. Two further selections of compounds from Professor Blackman are now under test, but no results were available at the end of the year. Small-scale testing of commercially available compounds continued. Substances showing promise were included in large experiments set up in Fields 18 and 20B during the course of the year.

Co-operation with the Chemical Division was continued in the conduct of field trials of bactericidal yield stimulant mixtures. At the R.R.I.E.S. one of the three field experiments was discontinued in the second half of the year, whilst preliminary work was in progress on three further experiments which are to be treated early in 1959. One trial was started on a co-operating estate and a second area is being recorded prior to treatment.

A number of experiments were carried out to investigate the possible uses of gibberellic acid in *Hevea* cultivation. Overnight soaking of fresh Tjir 1 clonal seeds in solutions of 0, 1, 10 or 100 p.p.m. of the potassium salt of gibberellic acid had no effect on the rate of germination or subsequent growth of the seedlings. Similarly, repeated applications over a three-month period of aqueous sprays of up to 1,000 p.p.m. had no effect on stem height, leaf number, colour, or general appearance of Tjir 1 clonal seedlings. Application of 1% gibberellic acid in lanoline to the bud-patch after cutting back delayed the shooting of buddings of clone PR 107. One per cent indole-3-acetic acid also resulted in a similar delay in shooting, but a combined treatment in which 1% of each substance was given did not result in greater inhibition. The later development of the treated buddings was completely normal, although they remained retarded in comparison with the untreated controls.

Gibberellic acid also showed little activity as a yield stimulant when tested at 0.1% or 1.0%, either alone or in combination with 1% 2,4,5-T.

Translocation of Growth Substances

Work on the chromatography and bio-assay of plant growth substances in latex continued. No evidence for the occurrence of indole-3-acetic acid (IAA) was obtained, despite the use of a variety of extraction techniques and chromatographic systems. A similar investigation also failed to confirm an earlier report of the identification of IAA in extracts of *Hevea* laminae. Where the solvent used was a 100: 3: 18 mixture of n-butanol, ammonia (0.880) and water, all chromatograms of ether-soluble substances showed an active area E 1 (Rf. 0.6 – 0.9, compared with a value of 0.3 for IAA). The active area corresponded, in a number of solvents, with colour reactions obtained with indole reagents. It has not yet proved possible to identify the substance or substances involved.

The aqueous solution remaining after extraction of the ether-soluble substances was freeze-dried and also examined for activity. Large amounts of extraneous

materials made chromatography difficult, but three active areas, termed A1, A2 and A3 were demonstrated with the n-butanol/ammonia/water solvent (Rf.'s A1 0.0–0.1, A2 0.2–0.3, A3 0.6–0.8). Although positive indole reactions were obtained for A1, this area of the chromatograms contained sugars and ninhydrin-reacting substances which may also be responsible for activity in the *Avena* coleoptile straight-growth test. A2 is mainly found in the aqueous extract, but traces sometimes occur in the ether-soluble extract, where it can be confused with IAA. It differs however, in certain of its colour reactions and chromatographic behaviour. It is apparently an indole compound. The third active spot gives neither colour reactions nor fluorescence under U.V. light. Its activity is highly labile and further investigation is difficult.

A number of trees of clone AVROS 50 were treated some distance below the tapping cut with a mixture of IAA in lanoline. A yield increase of approximately 40% was obtained and examination of the ether-soluble extract from the latex of the treated trees revealed the presence of considerable amounts of IAA (c. 1g/ml.) although none had been found previously. There was also a large increase in the level of the naturally-occurring indole growth substance E1 referred to above, suggesting conversion of IAA to the unknown indole. Control trees showed little change in auxin level. A similar experiment, using R.R.I. 1% 2,4,5-T mixture as the yield stimulant, also showed a large increase in the growth substance level, strongly suggesting the presence of 2,4,5-T in the latex of the treated trees.

Auxin Content of Latex

Investigations on trees of widely different yield capacity suggest that there is some correlation between high yield and high auxin content of the latex. It is apparent, however, that numerous other factors such as number and diameter of latex vessels, length of tapping cut, etc. must be taken into account and no simple relationship is to be expected.

Anatomy of the Bark and Root

It has again been confirmed that application of a stimulant above the tapping cut results in a thicker bark due to activation of the cork cambium. The number of latex vessels is not affected.

Co-operation was afforded to the Soils Division in sectioning root samples with the object of finding what length of root is capable of absorbing nutrients.

Growth Analysis

Work under this project was initiated during the latter part of the year and three experiments were set out. In the main, they are long term and it is not possible at this stage to report any results.

A study is being made of the effect of tapping on the increase in total weight of trees and the changes (if any) in the distribution of the growth between trunk, canopy and roots. Clones PR 107 and RRIM 520 are being used. Trees of both clones having a girth of between 10.0 in. and 21.0 in. on 1 June 1958 were selected for treatment, and also in the case of PR 107 those with a girth between 15.6 in. and 17.5 in.; having been grouped in this way for girth range they were assigned

arbitrarily to one of two treatments—in one, trees were opened for tapping on 1 July 1958 and in the other the trees will remain untapped for the duration of the study. At about the same date, 3 trees from each clone and for each range of girth were cut down, roots other than fibrous ones were collected, and estimates made of total tree fresh and dry weights. Representative tapped and untapped trees will be sampled in a similar manner at six-monthly or twelve-monthly intervals. Records of monthly girth increments and twice-monthly dry rubber yields are being kept. A 30–40% greater increment in girth has been noted in the trees remaining untapped over the first five months of tapping in this investigation.

In a second experiment, samples of trees from two 5-acre blocks of clones RRIM 501 and RRIM 513, which were budded during 1958, will be analysed half yearly for several years for changes in growth rate, distribution of this growth, girth increments and differences between the two clones. The girth of all stock plants, measured at 12 in. above the ground level, was taken prior to the cutting back of the stocks in the area in order to examine the effect of size of stock on the subsequent early growth of the budding. Records are being compiled of weekly increases in the heights of the buddings—at a later date a change will be made to measurement of monthly girth increments.

To examine the differences in growth rate, net assimilation rate and rubber content of plants of different clones, monoclone seedlings of clones PB 86 and AVROS 50 are currently being grown in pots of acid-washed sand in the greenhouse and provided with constant amounts of water and nutrients. Plants will be analysed just before the commencement of the extension of each succeeding node. Leaf area is estimated by preparing shadows of all the leaves on 'Ammonax' paper and relating the weight of these shadows to that of a known area on the same paper. A preliminary trial using unselected seedlings was run for three months in order to standardise experimental procedure.

Wind Damage

This has recently assumed a more significant position as a factor contributing to the loss of trees. Catastrophic destruction of trees of clones hitherto not considered liable to severe wind damage has occurred in certain districts. Heavier damage than anticipated has been widespread, although rarely amounting to total loss. Moreover an unduly high proportion of vigorous, high yielding clones have exhibited wind damage susceptibility. The problem is therefore receiving renewed attention. During the current year the types of damage have been classified, hypotheses to account for their occurrence have been formulated and experiments have been initiated to test these hypotheses; also to investigate possible methods of wind damage prevention, and early selection of wind resistant material.

ECOLOGY

Field Experiments

Various types of vegetation are found in rubber plantations and in cover plant trials, usually either herbaceous communities of grasses and creeping plants or shrub vegetation; there are also intermediate and mixed forms. Within the limits of the time available, no sampling method is ideal for all the forms of vegetation

encountered. In particular grass and creeper communities are better analysed by means of smaller quadrats than those which appear suitable for shrubs. This has been confirmed by recent field work. There is an indication in plots where the cover crop has been planted and the community is artificial that regularly arranged quadrats give a better analysis than quadrats chosen haphazardly or by means of random numbers. It is important to avoid subjective bias in the actual location of the quadrat on the ground.

These conclusions are being incorporated into a routine method of sampling of vegetation in cover plant trials. The trials established in 1956 replantings are now in good condition and virtually pure stands of the plants under investigation have been obtained. A further trial has been established in the 1958 replanting which compares 12 types of cover plant confounded with two methods of replanting, namely felling with poisoning of the stumps and uprooting of the trees, with clearing and ploughing by mechanised means. With the earlier trials, this experiment ensures that all the species commonly sown or occurring naturally in quantity on the Experiment Station are under investigation, including leguminous and non-leguminous plants with a wide range of rooting habits and growth forms.

Seed Treatment

Laboratory, pot and field trials of new methods of treating leguminous seeds to improve germination were in progress at the close of the year.

Two methods are useful advances on those currently employed. The first is not new in principle, and consists of mechanically scarifying the seed by rotation in a drum lined with sand paper. In the experimental model the drum is hexagonal in section (internal diagonal 8 inches) at right angles to the axis of rotation (length 17 inches). Rotation of 7 lb of seed at 75 r.p.m. for 28 hours proved very effective. The cost in electrical power was about 12 cents (Malayan) per pound of seed.

The second method is the immersion of the seed in hot, undiluted glycerine. The seeds may be immersed in glycerine at 70°C and left to cool, or kept in glycerine for 2 to 6 hours at 50°C. Ground rock phosphate is mixed in to render the seed easier to handle. It has been confirmed that dressing the seed with fine ground Christmas Island rock phosphate is advantageous. The glycerine should not be washed off nor should the seed be soaked in water. The grade of glycerine employed costs $11.25 (Malayan) per winchester bottle, which is enough to treat 10 lb of seed. This is relatively expensive, but will prove economic if it is substantiated by the field trials in progress that germination may be improved and seeding rates reduced without increasing the susceptibility to drought. Kerosene is not a good substitute for glycerine although it at first showed promise.

Kinetin at 1 and 10 p.p.m. and potassium giberellate at 10 and 100 p.p.m. employed separately and in combination did not improve germination significantly. Storage of seed wet or dry for 1, 4 or 7 days at 0 to 5°C had deleterious effects.

Herbarium

The herbarium specimens were rearranged and kept in steel cabinets in an air conditioned room.

ADVISORY

Lectures

The Head of the Division lectured on 'Planting Density' to the Malacca Planters Association on 8 March. He also lectured on 'Research Aids in Reducing Production Costs' to the following branches of the Incorporated Society of Planters:

Central Perak Branch, 21 June
Central Pahang Branch, 28 June
South Johore Branch, 2 August
Negri Sembilan Branch, 16 August
North Johore Branch, 30 October

Ir P. de Jonge lectured on 'Stimulation of Yield and Intensive Tapping' to the South Johore Branch of the Incorporated Society of Planters on 28 September. Mr J. M. Ross lectured on 'The Selection of RRIM Clones' to the Negri Sembilan Branch of the Incorporated Society of Planters on 14 December.

Visits

Research Officers made sixty-six advisory visits to estates. The bulk of these were in connection with problems concerning tapping, planting material and yield stimulation.

Identification of Clones and Inspection of Seed Collection Areas

Clone Inspectors visited two hundred and twenty-five estates for a total of three hundred and seventy-nine days in connection with the examination of seed collection areas and the identification of clones, both in the field and in the nursery. In a check of Government budwood nurseries, our Inspectors found a high standard of upkeep in most cases. At the end of the year the total area approved for seed collection purposes was 38,488 acres on one hundred and seventy estates. A commendation was received from the Rubber Producers Council of the Federation of Malaya in respect of this work.

Distribution of Cover Crops

Thirty-nine pounds of *Flemingia congesta* seed were distributed to eighteen estates, agricultural officers and others. Small quantities of seed in short supply such as *Psophocarpus palustris* and *Clitoria rubiginosa* and cuttings of *Stylosanthes gracilis* and *Desmodium ovalifolium* were supplied for trial on request.

Testing of Cover Plant Seeds

Ninety-four samples of leguminous seeds of commercial origin were tested as shown below:

NUMBER OF SAMPLES BY TYPE AND ORIGIN

Type	Supplier	User
Calopogonium	6	5
Centrosema	12	14
Pueraria	15	27
Others	14	1

Identification of Plants and Rubber Seeds

Twenty-nine specimens were received from estates and identified. Thirty-nine samples of seeds were received and identified.

Despatch of Planting Material

Planting material was despatched as under:

DESPATCH OF PLANTING MATERIAL OVERSEAS

Recipient country	Budwood, yards	Seed	Budded stumps
North Borneo	92	—	—
Indonesia	54	10,180	—
Thailand	25	—	—
Burma	450	—	—
United States	32	—	—
Great Britain	—	550	15
Papua and New Guinea	100	—	—
Total	753	10,730	15

Correspondence

The following is a summary of advisory correspondence:

		Letters received	*Letters despatched*
1.	Buddings — choice of clones	554	487
2.	Clonal seedlings — choice of material	13	13
3.	Tapping	125	110
4.	Yields in commercial tapping	17	25
5.	Replanting enquiries — hedge planting and planting distances	52	46
6.	Establishment of seed gardens and selection of areas for seed production	23	21
7.	Exchange of planting material	395	348
8.	General planting enquiries	436	559
9.	Tree poisoning	15	14
10.	Yield stimulation	118	95
11.	Identification of cover plants and rubber seeds	180	157
12.	Germination tests	95	115
13.	Identification of clones on estates	369	257
14.	Miscellaneous	150	142
	Total	1,363	1,339

Visitors

Sixty-eight visitors called upon the Division. The visits of Professor J. B. S. Haldane, Dr Helen Spurway, Dr K. S. Dodds and Mr R. J. Garner were most fruitful in discussion.

C. W. Brookson
Head of Botanical Division

Appendix

THE PROGRESS OF VEGETATIVE PROPAGATION OF *HEVEA BRASILIENSIS*

Figure 1

References are made in the text of the report to vegetative propagation of *Hevea brasiliensis*. Figure 1 shows a rooted cutting of clone FX 232, one of the *Dothidella*-resistant clones which is a cross between a Far Eastern *Hevea brasiliensis* clone and a clone of *Hevea benthamiana*. This cutting was rooted in coarse sand and the development of roots from the end of the cutting is obvious.

Figure 2 shows a rooted cutting of clone RRIM 526 which was rooted in a sawdust and sand mixture; the cutting was then removed from the propagation bed and planted out in a basket. After one week the cutting was again removed and the photograph taken. Here again considerable root development has taken place.

Figure 2

Figure 3

Figure 3 shows a rooted cutting of clone PB 86 growing in a nursery on poor soil. The ruler at the side of the cutting is one foot in length. The lower whorl of leaves that have been cut are the original leaves when the cutting was taken; since propagation two further whorls of leaves have grown.

Appendix

Figure 4

In the text of the report vegetative reproduction by large marcots is mentioned. Figure 4 shows a large marcot ready for harvesting, covered with black polythene. Roots can be clearly seen showing through the polythene. Figure 5 shows a similar marcot with the polythene removed, showing the development of the roots.

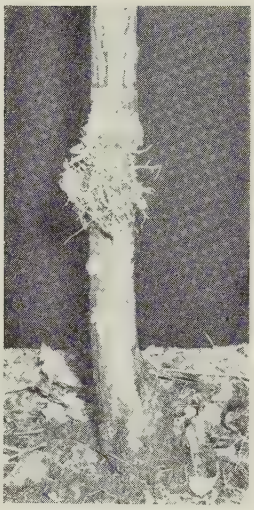

Figure 5

Considerable progress has been made with the development of cuttings in particular. Apart from a publication in the *Planters' Bulletin No. 45* page 143, which gives an outline of what has occurred, a full report will be available during 1960 on all work done on the subject.

Pathological Division

Dr A. Newsam, Head of the Division, went on home leave on 16 August when Mr F. W. Hutchison, Field Research Officer, took over duties of Acting Head. Until the time of his departure on leave Dr Newsam also devoted a large part of his time to editing the Institute's publications pending the vacancy of Publications Officer being filled.

Mr R. N. Hilton (Pathologist), Mr R. A. Fox (Microbiologist), and Mr B. Sripathi Rao (Assistant Entomologist) were on duty throughout the year. Mr K. P. John (Assistant Pathologist) was on home leave from 25 February until 7 August.

Mr Hoh Choo Chuan, the Institute's artist, whose excellent drawings and paintings have illustrated many of the Institute's publications, retired on 31 August after serving for 30 years.

Four papers were published in the *Journal of the Rubber Research Institute of Malaya,* Volume 15:

A. Newsam and B. Sripathi Rao.	Control of *Coptotermes curvignathus,* Holmgren, with Chlorinated Hydrocarbons
K. P. John.	Inoculation Experiment with *Fomes lignosus,* Klotzsch
F. W. Hutchison.	Defoliation of *Hevea brasiliensis* by Aerial Spraying
R. N. Hilton.	Pink Disease in *Hevea*

The following articles were contributed to *Planters' Bulletin :*

The Cost of Root Disease	*Planters' Bulletin 34*
Root Disease and Replanting	,, ,, *35*
Spraying Machinery for Estate Use	,, ,, *36*
Dusting Machinery for Estate Use	,, ,, *37*
Low Volume Sprayers	,, ,, *39*

A book, 'Maladies of Hevea in Malaya', by Mr R. N. Hilton, fully illustrated in colour by Mr Hoh Choo Chuan, has been completed. It is due from the publishers early in 1959. A companion volume on pests is being prepared.

Three lectures were given to branches of the Incorporated Society of Planters: by Mr R. A. Fox on 'The Results of Research on Root Disease' to the Central Johore branch in March; by Mr F. W. Hutchison on 'Where Root Disease Research is Leading Us' to the Negri Sembilan branch in March; and on the 'Recognition of Maladies' by Mr R. N. Hilton to the Lower Perak branch in June. In addition, Mr F. W. Hutchinson gave an address on 'Pests and Diseases' to managers of a planting group in Malacca, on 13 March.

RESEARCH

ROOT DISEASE

Inoculation Experiment

Examination of the roots of seven-year old trees which fifteen months previously had been inoculated with *Fomes lignosus* at a distance of 18 in. from the collar, with naturally infected sections of roots ranging in volume from 5 to 85 cubic inches, showed that out of the total of 115 inoculated, 32 had not been penetrated by the disease. Of the 83 showing penetration, only 6 had died up to the collar and in only 7 had penetration into the collar taken place. Collar penetration and root penetration were recorded where the volume of the inocula used was more than 47 cubic inches and 35 cubic inches respectively, although in one case there was penetration of the root where the inoculum was only 5 cubic inches. In many of the inoculated roots the progress of the disease had been arrested by barrier formation and callus growth from the edges of the wounds.

To study the importance of the original source of *F. lignosus* on subsequent development of the disease, inocula varying in volume from 35 to 125 cubic inches were placed in contact with roots and subsequently removed at intervals of four, five and six months. Examination of the roots fifteen months after inoculation showed that the disease was firmly established in the new host root within a period of four months. The presence or absence of the original source of infection after this period apparently had no effect on the future progress of the invasion.

A technique of pure culture inoculation has been developed and used in the field to inoculate the collar and lateral roots. Preliminary examination encourages the belief that reproducible infections by pure cultures may now be obtained which will permit a study of variations of host resistance and of fungal pathogenicity.

Root Disease Control

Two further rounds (ninth and tenth) of inspection and treatment of root disease have been concluded in experiment CI-51 (See *Annual Report 1951,* p.8). It is evident that the general downward trend in incidence continues and total losses from untreated plots are still markedly less than those in plots where treatment and eradication have been carried out.

Experiment CI-56, comparing poisoning treatments described in *Annual Report 1956,* p.41, has been inspected and two rounds of treatment given. It is too early to attempt to interpret the results but it is interesting to note a remarkable reduction, about tenfold, in incidence at the second round. Where stumps of the old stand were treated on the cut surface with a wood preservative, approximately half as many had to be removed as sources of infection, compared with stumps not so treated.

An area in Field 17 on the Experiment Station has been laid out to compare the effect on root disease of mechanical clean clearing with felling, burning and stump poisoning.

In Field 24, an experiment was initiated in 1956 to compare the effects on the subsequent incidence of disease of poisoning and not poisoning with sodium arsenite, in conjunction with creosoting and not creosoting the cut surface of

stumps; it is yielding interesting information confirming observations made on stump colonisation by spores in experiments G-50, CI-51 and more recently in CI-56. Although complicating factors have made their appearance, principally associated with the effect of topography on disease distribution by wind-blown spores, it is apparent that this surface treatment has resulted in the number of infected stumps being materially reduced.

Fundamental Studies

During 1958 further laboratory screening tests of potential collar fungicides have been carried out and a selected few used in small scale field trials. Experiments in the field are continuing but none of the fungicides used in the initial tests entirely prevented superficial growth of the fungus from reaching the collar. It remains to be seen whether the degree of inhibition achieved will be sufficient for the inherent resistance of the tree to halt further disease progress. More than sixty fungicides and other chemicals have been tested against *F. lignosus* in culture where the fungus shows remarkable adaptability (and consequently tolerance) to a wide range of chemical compounds.

An experiment is in progress in Field 42 on the Experiment Station, to determine relationships between root disease and yield, the composition of the latex, and the nutrition of the tree. The Botanical, Soils and Chemical Divisions are collaborating by recording yield and by analysing latex and leaf samples.

Laboratory investigations are being concentrated on factors affecting the initiation and growth of rhizomorphs and on physiological variations between isolates.

Temperature and pH of inoculum have been studied in relation to initiation and subsequent growth of rhizomorphs under dry and wet conditions in the laboratory. The interactions are complicated but generally it can be stated that low pH in the inoculum stimulates rhizomorph initiation, early linear growth and rhizomorph thickness and the same effect is obtained with high temperature. Rhizomorph growth will not occur unless the (soil) air is at or near saturation point and growth is most rapid when free water is available; in the latter case, however, growth may be retarded if there is not sufficient free or dissolved oxygen. The pH of the medium (soil solution) surrounding the rhizomorph may overrule the effect of the pH of the inoculum, but the effect of varying the pH of the medium through which the rhizomorph grows has yet to be determined. Temperature becomes a limiting factor when it falls below 70°F.

Growth rate analysis of isolates of *F. lignosus*, taken from different sources and grown at two pH levels, pH 4.6 and pH 6.0, are yielding interesting results. At both pH levels spore cultures show the slowest growth rates and isolates from rubber are slower-growing than those from other hosts. Most isolates from fructifications, like those from spores, grow slowly. Within these general groupings however, there are interactions between isolate and pH level. It is clear that different strains of the fungus exist and that the differences remain stable in culture over a long period. This is quite different from the case of *F. noxius* where the isolates not only decrease in growth rate on subculturing but also change morphologically. It is surprising that *F. noxius*, when first isolated, grows faster than *F. lignosus*, although it is much slower to spread in the field.

A considerable body of quantitative data on fructifications has been amassed, based on size of spores, and on diameter and wall thickness of hyphae, both from

the fructifications and appropriate cultures. Fructifications have at last been found in the jungle and in the same locality as those of *Polyporus rugulosus*. The spores of *F. lignosus* from jungle fructifications were larger than those found on rubber.

Spore Dissemination

Field experiments G-50, CI-51, CI-56 and that in Field 24, as well as numerous field observations, have shown that spore infection of stumps plays an important part in the propagation of root disease, and that the simple expedient of treating the exposed cut surface, immediately after felling with a cheap wood preservative such as creosote, results in a lowered incidence. Preparations have been made to study intensively this aspect of root disease propagation and methods to control spore colonisation. *F. lignosus*, being the most important of the diseases in immature rubber, has been chosen for the initial investigation. Preliminary observations have been made on the spore production from sporophores held at relative humidities ranging from 20–100% and on methods of encouraging the natural production of fructifications in the field, for studies on spore dissemination.

Decay of Rubber Wood

The rate of decay of rubber wood is of considerable importance from the point of view of root disease propagation. Following the start made last year on an investigation into the rate of decay and the organisms causing it, a further experiment was laid out in part of Field 6 on the Experiment Station. Trees and the stumps of felled trees in this area were poisoned with either sodium arsenite or 2,4,5-T. Some of the stumps and trees were additionally treated with insecticides to reduce the activity of insects so that the role played by insects might be assessed.

Borers were the first invaders, especially into the stumps and standing trees poisoned with sodium arsenite. Where 2,4,5-T had been used borer population was considerably less. Stumps treated with the insecticides were free from borers, though unsuccessful attempts were made to penetrate those poisoned with sodium arsenite. Insecticidal treatment of the trees did not keep out borers, due no doubt to the large volume of untreated timber, but reduced their numbers. The borers disappeared as the stumps and trees slowly dried up. On the fungi that were actively growing on the poisoned stumps and trees, fungus-feeding beetles were numerous, their number and activity increasing as the legume covers grew over the stumps and round the bases of trees. A large number of bark feeding and predatory beetles were also present underneath the peeling bark.

The observations so far have been confined to those parts of the trees and stumps above-ground, and take no account of observations to be made of below-ground colonisers. A large collection of beetles of the families Anthribidae, Brenthidae, Buprestidae, Carabidae, Cerambycidae, Cetonidae, Colydiidae, Cucujidae, Elateridae, Endomychidae, Erotylidae, Passalidae and Tenebrionidae have been made. In the larval stage, some of them have been found to make complex tunnels in the wood; but the majority were only feeding on and disintegrating wood that had already decayed fully. Aradid bugs were also found under the bark especially where it was covered by legume growth. In general, it could be said that the part played by insects in the decay of rubber wood was small.

Fungi played a much more important part in the decay than insects, with a definite succession of species. The earliest colonisers were a species of *Fusarium*

and an unidentified dark green fungus. Thirteen other species of fungi with fructifications were recorded but this list is by no means complete. *Schizophyllum commune* was the most prominent in the early stage, giving way to *Trametes corrugata*. Other species recorded were *Daldinia concentrica, Ganoderma applanatum, G. lucidum, Hydnum duriusculum, Lentinus* sp., *Lenzites repanda, Panus* sp., *Polyporus anebes, P. occidentalis, P. rugulosus, Polystictus vittatus* and *Xylaria* sp. Eighteen months after poisoning and six months after the stumps had been enveloped in the creeping legume cover, all the stumps were in an advanced state of decay. In contrast to the observations on insect populations there was some difference between the extent of decay in stumps treated with the two poisons. Stumps treated with sodium arsenite, on the whole were not in such an advanced stage of decay as those treated with 2,4,5-T.

Tree and Stump Poisoning

Continuing studies on tree and stump poisoning, work has been concentrated on methods designed to improve the performance of 2,4,5-T which is inclined to give erratic results. These have included observations on the condition of the bark at the site of application, additives to the 2,4,5-T solutions, and concentration/volume relationships. Alternative poisons, pentachlorphenol and endothal, have been tried but proved useless. Another aspect of poisoning on which observations continue to be made concerns the effect of felling trees at intervals after poisoning.

As the result of work to date it can be generally stated that the use of 2,4,5-T results in more rapid decay of the stumps than does sodium arsenite. The effect of addition of copper is being investigated. With 2,4,5-T a high-volume/low-concentration combination has given more consistent results when it is used as a tree poison, although this difference is not evident if the application is made to the stump of a felled tree. No consistent result has been obtained in experiments to study rate of death of the roots of trees felled at intervals after poisoning nor is the effect of bark condition at the site of 2,4,5-T application on the efficacy of poisoning yet understood.

An attempt is being made to destroy stumps of felled trees *in situ* by burning after allowing them to become impregnated with saltpetre placed in auger holes, the stumps being previously poisoned with sodium arsenite. Observations are being made on Carey Island, on a small scale. Saltpetre has been applied at intervals after felling and attempts made to burn treated stumps three and six months later. Early efforts at burning have not been successful, the stumps still being too green.

PANEL DISEASES

Two proprietary fungicides were submitted for testing under the official approval scheme for use against mouldy rot. However, weather conditions were such that the disease failed to develop the intensity required, and testing was incomplete by the end of the year.

BRANCH DISEASES

Continuing the study of pink disease on the Experiment Station, it is recorded that the pink-crust stage was not common during the dry conditions prevailing in the first half of the year and on the whole disease incidence has been low, with sporing material in short supply. The necator stage was collected only once.

Further unsuccessful attempts were made to inoculate branches of susceptible trees with spores collected with a hand-operated spore trap. Coherent mycelial mats have been produced in culture but the cultures have not been made to produce spores.

Two years' observations of diseased trees on the Experiment Station confirm statistically that RRIM 501 was the most susceptible clone to pink disease, followed by Tjir 1. Investigations into the effect of planting distance on incidence have shown no significant correlation and heavy application of potash to trees of 5 to 6 years old over a period of two years has failed to provide any significant reduction in disease incidence.

LEAF DISEASES

During March and April twenty reports of secondary leaf fall were received from different parts of the country accompanied by 97 specimens. These figures were the lowest for several years. *Gloeosporium* was dominant, followed closely by *Oidium* and mites, then thrips.

DISTRIBUTION OF RECORDS OF SECONDARY LEAF FALL, 1958

Territory	March	April	May	Total
Perak	—	1	—	1
Selangor	2	2	—	4
Negri Sembilan	—	5	—	5
Kedah	2	4	—	6
Johore and Singapore	2	1	—	3
Pahang	—	1	—	1
Total	6	14	—	20

INCIDENCE OF THE PARASITES ASSOCIATED WITH CASES OF SECONDARY LEAF FALL

Parasite	Percentages of cases in which: present		no other parasite present	Mean intensity of attack
	March	April		
Oidium	16.5	53.6	4.1	1.8
Gloeosporium	16.5	41.2	6.2	2.0
Mites	13.6	63.9	6.2	1.8
Thrips	6.2	8.2	—	1.4

Control experiments have been continued in nurseries heavily infected with bird's eye spot. In the early part of the year tests were undertaken with six fungicides, Bordeaux mixture (4: 5: 40) Perenox, Trifungol (ferbam), Triscabol (ziram), captan and mercurised copper oxychloride, applied at weekly intervals with a motorised knapsack low-volume sprayer. Mercurised copper oxychloride,

which in previous trials had given an indication of its superiority in controlling the disease, again proved to be the best. None of the other fungicides tested showed much promise. Lack of coverage appears to be part of the reason for the failure to secure adequate control and trials are now aimed at overcoming this defect by the use of a spray oil as carrier for the fungicides in conjunction with the use of a low-volume mist blower. Copper and mercurised copper fungicides are being used.

PESTS

Termites

In continuing tests of residual toxicity to *Coptotermes curvignathus* of soils treated with chlorinated hydrocarbons, dieldrin still retained its lethal character after four years in both lateritic and volcanic soils and in two sandy loams. Its toxicity in clay soil had been lost after 34 months. Aldrin, chlordane and endrin had already lost their activity in the six soil types studied. In peat soil, all the materials quickly lost their effectiveness when applied at the usual dosage rates. Aldrin has proved more effective in this type of soil than dieldrin—at twice the standard dose aldrin retained its toxicity for nine months whereas soil treated with dieldrin became non-toxic after five months. When the dosage was increased fourfold in peat soil the periods of retained toxicity were fourteen and nine months respectively. Even at four times the standard rate, chlordane lost its toxicity within one month.

A high degree of correlation has been shown to exist between the persistence of aldrin and endrin in different soil types with cation exchange and moisture holding capacity of the soils. There is however, no significant correlation between effectiveness and percentage organic matter or clay content.

Cockchafers

Of the seven estates which in 1957 suffered severe cockchafer infestation, four reported re-infestation again this year. A small experiment was laid down on one of them where the cockchafer *Holotrichia bidentata* was active, to find out whether the legume cover *Pueraria* could be saved by chemical treatment of the soil. Aldrin and gamma BHC emulsions were injected at the rate of 6, 10.8 and 13.8 lb aldrin and 2.4, 4.4 and 5.6 lb gamma BHC per acre. Examination of the cover after treatment showed that all insecticides were successful in protecting the *Pueraria*. No difference above ground could be noted between the treatments and dosages, but the number of live grubs was progressively lower with each higher dosage.

On two other estates, where aldrin was used in 1957 for the protection of young trees against the grubs of *Holotrichia bidentata,* this treatment effectively protected the trees from a severe re-infestation this year.

Soil samples from the collar region of trees treated in November 1957 with four pints of 0.1% aldrin or 0.4% gamma BHC emulsion were assessed for their residual toxicity. Grubs of *H. bidentata* were confined in the two soil samples and in an untreated soil as control. Those confined in the soil treated with aldrin were all dead within five days but those in the gamma BHC soil and in the untreated control continued to feed normally and completed their life cycle. The superior residual toxicity of aldrin was indicated.

PESTS AND DISEASES OF COVER CROPS

Four distinct strains of root-knot nematode that were indicated by cross-inoculation tests have been provisionally identified by the Rothamstead Experimental Station as follows: *Calopogonium* strain—*Meloidogyne arenaria; Desmodium* strain—*M. incognita* var. acrita; *Flemingia* strain—*M. javanica; Pueraria—Centrosema* strain—*M. javanica.* The inability of the *Flemingia* strain to infect *Pueraria* and *Centrosema* is recorded.

The Agromyzid, whose maggots were found last year infesting the roots of *Calopogonium* and *Centrosema* seedlings has been identified as *Melanagromyza centrosematis* (de Meij), by the Commonwealth Institute of Entomology.

MISCELLANEOUS INVESTIGATIONS

The Mirid bug found puncturing unopened *Hevea* flowers and contributing to premature flower fall has been identified as *Lygus* sp.

Soil respiration studies have been made on behalf of the Soils Division in connection with a cover crop trial which is in progress in Field 23. A suitable method for further studies has been suggested.

A cover crop experiment in Field 17 has been laid out to investigate seed dressings and other preplanting treatments in collaboration with the Botanical Division.

Hevea seedling roots collected from an experiment to study nutrient uptake from organic matter were examined for mycorrhiza. Mycorrhiza were found of the vesicular-arbuscular type but only in seedlings growing in pots 'inoculated' with feeding roots from rubber. Fundamental observations have been made and the fungus tentatively assigned to the genus *Rhizophagus.*

ADVISORY

ROOT DISEASE

The revised recommendations on root disease control published in *Planters' Bulletin 35,* aroused widespread comment. Unfortunately, in many cases this advice has been taken to imply that discontinuance of general collar inspection means discontinuance of any measures of control and a warning that this is not so has been prepared for insertion in *Planters' Bulletin 40.* Root disease enquiries continue to demand the greatest attention in correspondence and estate visits, but advice is usually sought on specific aspects such as methods of eradication in young mature areas or in areas due for replanting. Identification of root disease on specimens, both rubber and covers, is continually required.

PESTS

A severe infestation of *Tetranychus telarius* on *Pueraria phaseoloides* has been controlled by spraying with 0.1% Tedion V18 wettable powder alternated with 0.12% of malathion.

The renewing bark on the panel of a few mature trees has been reported to be damaged by caterpillars of the Noctuid moth *Homodes brachteigutta;* an unidentified cricket has also been found causing similar damage.

On one estate where reduced vigour was primarily the cause of poor growth, a Cantharid beetle was encountered eating the bark of stumps.

An interesting case of damage to a large number of young buddings in a new planting on the Experiment Station, has been caused by the tree shrew *Tupaia glis*. The damage was characterised by pin-pricks of exuding latex with the young bud shoot bitten off by a straight or slanting cut, the soft stem being eaten from the proximal end.

The lac insect, reported at the end of 1956 as infesting four-year-old RRIM 501 buddings, has been identified by the Commonwealth Institute of Entomology as *Laccifer greeni* (Chamberlin).

Unfavourable weather and heavy insect attacks have been generally responsible for the poor growth of legume covers this year. Spraying with D.D.T. emulsion has been highly successful against beetles when carefully applied and so has endrin against the caterpillars of *Lamprosema diemenalis*.

Cockchafers have been more troublesome this year and the species *Holotrichia bidentata* was the most commonly encountered. Adequate protection of newly planted seedlings has been obtained by watering the soil round the planting points with four pints of a 0.1% aldrin, or 0.04% gamma BHC solution. Aldrin, however, possesses greater residual toxicity.

MISCELLANEOUS

In Johore, an outbreak of *Oidium* on six-month-old seedlings in the field, associated with elongated leaves and rosetting, was suspected to be the result of zinc deficiency. Symptoms appeared after a drought period and disappeared when rain came. An association of zinc deficiency with *Oidium* was reported previously in pot experiments (*Annual Report* 1955, p.21.).

Investigation into the repeated failure to establish legume covers on an estate in Selangor showed that nearly all the dead roots were heavily infected by a fungus of the order Peronosporales, probably a species of Pythium. A few lesions appeared to be due to a *Rhizoctonia* sp. which has also been found attacking and causing the death of leaves of *Pueraria* and *Mikania* in field plantings.

Dieback of lower branches in an area of four-year-old PR 107 trees was investigated and several isolations produced a species of *Phomopsis*. Inoculation of year-old seedlings in a nursery failed to establish the pathogenicity of the fungus. The death of these lower branches appeared primarily due to heavy shade.

The demand for packaged *Rhizobium* compost culture for the inoculation of legume cover seeds, continues at last year's high level. 11,200 packets were distributed.

Summary of Advisory Work and Correspondence

Letters despatched	414
Specimens examined	271
Visits to estates and smallholdings ...	210
Interviews	84

F. W. HUTCHISON
Acting Head of Pathological Division

Chemical Division

At the beginning of the year, the graduate staff of the Division comprised Mr W. G. Wren (Head of Division), Mr G. W. Drake, Dr W. A. Southorn, Mr R. S. Gale, Mr J. E. Morris, Mr G. F. J. Moir, Mr D. H. Taysum, Mr B. C. Sekhar, Mr C. A. K. Salgado, Mr T. V. Molesworth, Mr K. C. Sekar, Mr R. C. H. Hsia, Mr S. J. Tata, Mr ST. Sethu and Mr A. Karunakaran.

Mr D. J. Graham continued to divide his time between Chemical Division and Experiment Station duties.

Mr K. C. Sekar retired in March.

Mr G. W. Drake and Mr D. H. Taysum went on leave in May. Dr F. W. Shipley was seconded from B.R.P.R.A. to work on latex problems, arriving in August, and Mr P. S. Nielsen, Rubber Technologist, took up duties in Malaya in October.

Mr R. C. H. Hsia and Mr ST. Sethu were occupied the whole year in research and study courses in the United Kingdom.

The posts of Analyst, Latex Technologist and second Biochemist remained vacant throughout the year, although a candidate for the Latex Technologist post has been selected and it is hoped he will take up duties in Malaya during 1959.

The Division continued to maintain liaison between the Committee of Malayan Latex Technologists and the British Standards Institution Sub-Committee RUC/10/7, which deals with specifications for latex testing. Contact has also been maintained with Committee D-11, Sub-Committee of the American Society for Testing Materials, which deals with latex and raw rubber; Mr G. W. Drake attended the meetings of the Latex and Raw Rubber Committees at Boston in June.

The Division has co-operated with the Ministry of Commerce and Industry on the question of technical specifications of Malayan natural rubber products for allocation to the Australian Government Customs Tariff.

Exchange of views by correspondence, memoranda and visits has been continued with sister research institutes through the medium of the International Rubber Research Board and the International Rubber Development Committee; the June meetings in Paris were attended by the Director of the R.R.I. whilst on leave and the December meetings in London by Mr Drake, who was on leave in Great Britain. Mr B. C. Sekhar attended the Polymer Conference at Nottingham in July, spent some days at Welwyn at the British Rubber Producers Association, and also made contact with other research and trade organisations, including a visit to the Institut Francais du Caoutchouc in Paris.

Mr Wren broadcast a short talk from Radio Malaya in June on 'Superior Processing Rubber' and addressed the Conference held at Kuala Lumpur in August, by the Government Senior Normal Graduates' Association, Selangor, on the 'Importance of Rubber in Malayan Economy'. Mr Moir took an active part in the symposium 'Chemistry in the Service of Malaya' held at the University of Malaya in August.

Published contributions to scientific journals were as follows:

B. C. Sekhar.	Natural Rubber Latex as Initiator for Vinyl Polymerisation. *J. Rubb. Res. Inst. Malaya* 1958, Vol. 15, p. 205.
B. C. Sekhar and G. W. Drake.	Superior Processing Rubber Masterbatch. *J. Rubb. Res. Inst.* Malaya 1958, Vol. 15, p. 216.
J. A. Gascoigne*, W. G. Overend*, G. F. J. Moir and G. Hubscher*	Co-enzyme A and Aldolase in Rubber-bearing Plants. *Nature, Lond.* 1958, Vol. 181, p. 628.
D. H. Taysum.	A Possible Basis for Phyto-immunity. *Nature, Lond.* 1958, Vol. 181, p. 174.
R. C. H. Hsia.	Oxygen Absorption by *Hevea brasiliensis* Latex. *I.R.I. Trans.* 1958, Vol. 34, p. 267.
B. C. Sekhar.	Aeration of Natural Rubber Latex. I. Effect of Polyamines on the Hardness and Ageing Characteristics of Aerated Latex Rubber. *Rubb. Chem. Technol.* 1958, Vol. 31, p.425.
B. C. Sekhar.	Aeration of Natural Rubber Latex. II. Graft Polymerization of Vinyl Monomers with Aerated Latex Rubber. *Rubb. Chem. Technol.* 1958, Vol. 31, p. 430.

The following articles were published in *Planters' Bulletin:*

Technical Classification of Natural Rubber	*Planters' Bulletin*		*35*
Firewood for Smokehouses	,,	,,	*35*
Superior Processing Rubber	,,	,,	*35*
Water Pollution	,,	,,	*36*
Removal of Water from Coagulum in Sheet Manufacture	,,	,,	*37*
Utilisation of Skim Rubbers	,,	,,	*38*
Low Temperature Rubber	,,	,,	*38*
Superior Processing Rubbers	,,	,,	*39*

In connection with Technically Classified Rubber, the following document was prepared for the I.R.R.B.—*Technical Bulletin No. 37*, May 1958.

The following internal reports were prepared:

R. S. Gale.	Chemical Division Report No. 14—The Drying of Sheet Rubber Part 4. The Water Absorption of Sheet Rubber.
R. S. Gale.	Chemical Division Report No. 14—The Drying of Sheet Rubber Part 5. Dimensional Changes during Machining and Drying of Coagulum.

* of the University of Birmingham.

T. V. Molesworth.	Chemical Division Report No. 15—Water Pollution and Effluent Treatment.
R. S. Gale.	Use of 'Mac & Lai' Additive by Smallholders.

The account of work carried out by the Division which follows is presented in four main sections: Fundamental Research, Applied Research, Process Evaluation and Advisory Work.

FUNDAMENTAL RESEARCH

BIOCHEMISTRY

Latex Fractions

The main advance in this field has been in defining the number and appearance of the visible components of fresh latex obtained by high speed centrifugation under fully refrigerated conditions. So far, eleven separate zones have been distinguished, six of which comprise the 'bottom fraction'. A technique of pre-staining the latex with vital stains has been developed which assists differentiation of the zones. It now seems clear that latex must contain a greater variety of particles than had previously been supposed and current observations require the postulation of the following in addition to rubber particles, lutoids, Frey-Wyssling particles and bacteria:

1. a light particle stained blue by Janus Green B
2. a particle which is difficult to sediment
3. at least one variety of particle which readily reduces Janus Green

It would be desirable to relate these particles to recognised categories of particles known to plant cytologists, but sufficient data are not yet available, either on the particles observed or on the precise cytological status of the contents of latex vessels of mature *Hevea* in regular tapping. It has been suggested, however, by WIERSUM (*Vakblad voor Biologen* 1957, Vol. 37, 17) that lutoids may be considered as the elements of a polydisperse vacuome; our observations do not contradict this view. Tentatively it could be suggested that the material which is difficult to sediment includes nucleoprotein, and derives from an ergastoplasmic structure. The particles exhibiting Janus Green reduction could be mitochondria. Much more work is required to be done before these tentative interpretations can be accepted as valid.

Latex Proteins

Paper electrophoresis. Further modifications in the technique of paper electrophoresis have been tried for separation and identification of latex proteins. A large Durrum-type apparatus accommodating twelve paper strips has been constructed and has given useful service. Examination of the bottom fraction from latex of clone PB 186 showed the six components previously reported to be common to a number of clones.

More refined techniques for resolving protein mixtures have now been examined, including electrophoresis in starch gels and ion exchange chromatography on cellulose derivatives.

Starch gel electrophoresis. Other workers have demonstrated that for blood serum proteins electrophoresis in a starch gel buffered with borate or phosphate has a much higher resolving power than electrophoresis on paper or in free solution (Tiselius apparatus). Our own experiments using *Hevea* latex proteins quickly confirmed the high resolution, as illustrated in Figure 1. The electropherogram shows seventeen individual components obtained with reconstituted serum (freeze-dried C serum) from mixed seedling latex. Paper electrophoresis had to date shown no more than seven components for reconstituted serum. It soon became apparent that the new technique could supply much further information on latex proteins and might well be sensitive enough to distinguish clearly between mixtures of latex proteins from different clones. Further work presented several problems which are now being studied.

The first of these is the difficulty of relating electrophoretic patterns observed on starch gel to those observed on paper, and thus of linking new observations with existing knowledge. This problem has so far evaded solution by direct comparison, owing to the difficulty of obtaining clear patterns by both methods using the same conditions of buffering. It is now proposed to perfect gel electrophoresis in borate buffer and to relate the findings to those obtained with paper using the customary veronal buffer, by working with purified individual protein components. Other problems include variability in supplies of starch, design of electrode compartments, and the determination of optimum conditions for obtaining maximum resolution and clarity with *Hevea* proteins. Since the technique has not, as far as we know, previously been applied to plant proteins, published information offers only limited guidance.

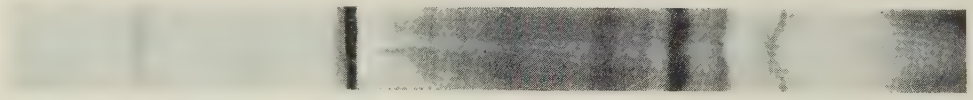

Figure 1. Electropherogram obtained on starch gel with concentrated C serum from a mixed seedling latex, showing seventeen bands, each of which probably indicates at least one individual protein component.

Ion exchange chromatography. The chromatography of proteins on ion exchange materials prepared from cellulose has been established as a powerful means of resolving complex protein mixtures (Sober and Peterson *J. Amer. chem. Soc.* 1956, Vol. 78, 751, 756), and we are now applying the technique to *Hevea* latex proteins.

The experiments were carried out using latex from a stand of seedling trees; the bottom fraction was separated out by high speed centrifuging under fully refrigerated conditions. B serum was obtained from the bottom fraction by freezing, thawing and recentrifugation. Paper electrophoresis showed that it contained a mixture of proteins similar to that obtained from the bottom fraction by other methods; it included 'component (vi)', the protein of highest anionic mobility which has been designated 'protein C' by our colleagues at the B.R.P.R.A.

When B serum was dialyzed against phosphate-citrate buffer of pH5 and washed through a column of CM cellulose with the same buffer, the eluate was found to contain only component (vi) on examination by paper electrophoresis. The other

B serum proteins were adsorbed on the column and by washing with a series of buffer solutions at increasing pH values, it was demonstrated that successive elution of these other components could be obtained. The somewhat elaborate technique for complete separation of all the components has yet to be worked out.

An interesting development with material in the pH 5 eluate is the discovery that it contains at least two different substances, despite its apparent homogeneity on paper electrophoresis. One of these appears to be the crystallisable protein C (Hevein) previously isolated at the B.R.P.R.A. Our work on the second component has demonstrated that it too is crystallisable, but in a form different from Hevein. Photographs of the two crystalline protein components are shown in Figure 2. Further studies are now in hand to separate, purify and characterise these two components.

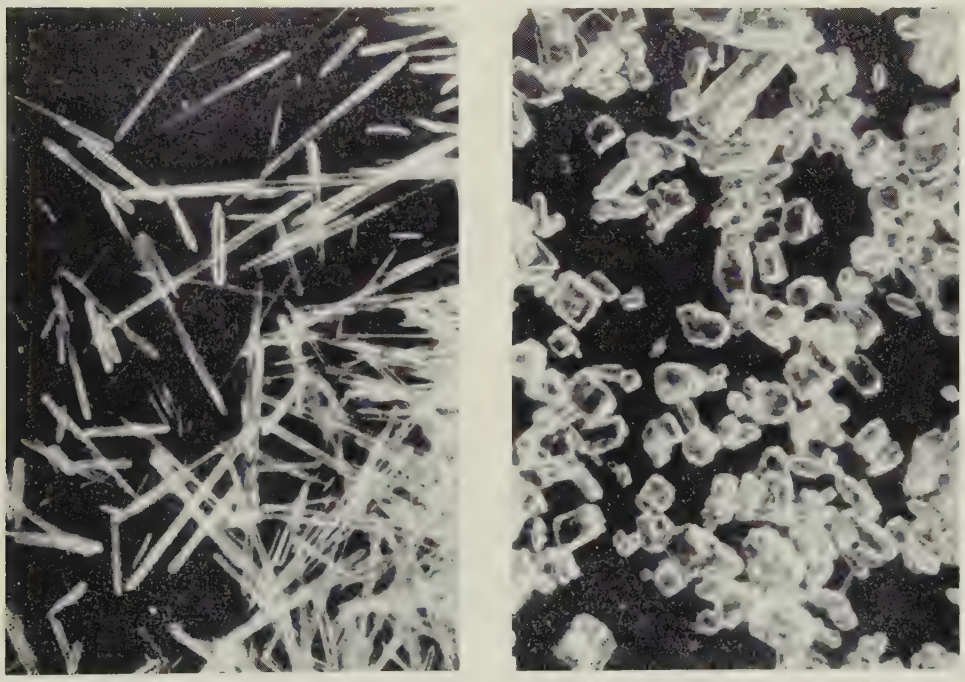

Figure 2. Photomicrographs showing two types of crystalline components separated from latex bottom fraction by ion exchange chromatography at pH 5. The needles are thought to be 'Hevein', the prisms another protein.

Volatile Fatty Acids

A study on volatile fatty acid formation in latex concentrate has demonstrated fairly conclusively that viable bacteria are necessary for its formation in appreciable quantities. Observations prior to these experiments which appeared to demonstrate development of V.F.A. in sterile or near-sterile latices have now been shown to have arisen from errors in the interpretation of plate counts.

Freeze-dried Latex Fractions

The supply of freeze-dried latex fractions to the B.R.P.R.A. continued during the year. The trees from which latex is taken for this work are in Experiment Station Field 20A. At the end of June the tapping cuts on these trees were approaching ground level, and on 1 July a new panel was started on the other side of each tree in the ordinary way. Preparation of fractions was continued but it was considered that they should be regarded as abnormal for a few weeks after the change of panel.

MICROBIOLOGY

Further trials have been made applying bactericidal treatments to rubber trees, with a view to studying effect on yield and latex quality. In general it has been found that treatment of the scraped tapping panel with vaseline containing antibiotics has given an increase in yield comparable with that obtained with 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). For low yielding trees the response is greater, for higher yielding trees it is somewhat less. Trials combining 2,4,5-T with the antibiotic treatment show that the combination sometimes gives higher yields than 2,4,5-T alone.

Bark renewal after treatment with 2,4,5-T may be defective, but with the antibiotic grease alone, satisfactory renewal has been obtained in most cases. Treatment of the cut prior to tapping with alkaline aqueous antibiotic dressing resulted in poor bark renewal. It should be noted that the above observations are tentative, being based on small-scale initial experiments.

COLLOID CHEMISTRY

Studies have been continued relating the colloidal stability of latex with its behaviour on coagulation. Further work on the torsiometer, an instrument devised at this Institute to measure the development of structure in latex when coagulation occurs, now permits us to express results for an elastic material in terms of a rigidity modulus instead of in purely arbitrary units. Investigations into the rheology of latex coagulum show it to be a viscoelastic material in which the elastic elements predominate over flow elements. These properties, which determine the way in which coagulum changes shape under deforming stress, as for example in machining, are being examined further.

A series of experiments, employing a new machine devised to measure gelling time of latex after adding a chemical coagulant, has given interesting results on an aspect of coagulation to which the torsiometer is not suited. The significance of gel strength at rupture, as distinct from modulus, is brought out in these experiments, which it is hoped will have application to foam rubber latex testing.

A further series of experiments in which latex was coagulated or destabilised by shear alone, demonstrated differences between latices in the times required for coagulation. In this apparatus, latex was sheared between two metal surfaces made to slide over each other with a reciprocating motion. Coagulation of the latex was indicated by an increase in the electrical resistance between the surfaces. Although this test resembles the standard Mechanical Stability Test for latex concentrate in applying shear to latex particles until agglomeration sets in, no

correlation between the two could be established. These studies are being continued with the hope of analysing the different factors controlling mechanical stability and the development of structure and tension strength on coagulation.

Installation of the 500 W (1.2 megacycles) h.f. generator has been completed and the output matched with the barium titanate transducer. Experiments with both l.f. and h.f. ultrasonic waves have been found to have only a small effect upon bacteria in latex. The possibility of sterilising latex by this means now seems somewhat remote.

Experiments to determine the effect of h.f. and l.f. radiation upon latex fractions separated by high speed centrifugation are in progress, with a view to determining whether modifications in the structure of certain particulate constituents can be obtained and whether enzymes or other protein components can be denatured.

POLYMER CHEMISTRY

Graft Polymers

The increase in hardness conferred upon the rubber hydrocarbon by grafting on side chains of a vinyl co-polymer is a valuable property which has found commercial application in foam rubber production as well as other fields. It has been demonstrated that changes occurring in the rubber hydrocarbon during normal manufacture and shipping to consuming countries modify the reaction between rubber and the added polymer, thus yielding somewhat different products. The final properties of the co-polymer graft depend to some extent upon the length and number of the secondary polymer side chains added. Recent experiments using methyl methacrylate have demonstrated that within limits the side chain length decreases with increase in the concentration of the initiator used to induce polymerisation. The length or molecular weight of the side chain is also roughly proportional to the concentration of monomer present, at a given initiator level. By grafting in stages, making successive additions of monomer, control of the chain length can be obtained. The influence of the molecular weight of the rubber hydrocarbon upon the grafting process is now under investigation.

The use of azo-bis-isobutyronitrile (AZBN) as an initiator in place of cumene hydroperoxide has been investigated. Whilst grafts can be prepared in this manner, the amount of secondary polymer attached appears to be limited and was found never to exceed about 18%.

The use of aeration to develop peroxides in rubber latex as initiators for graft polymerisation has been examined. It was found that the physical characteristics of the graft polymer particles was somewhat different from those obtained by activation with an organic peroxide. Thus film-forming properties on drying the latex and wet gel strength on coagulation were both superior in the aeration grafts. (See Figure 3).

Aeration can also be used to prepare graft co-polymers by stages, the graft latex being re-aerated to produce peroxides before further addition of monomer. The effect of this process on the molecular weight of the side chains is now under investigation; preliminary results indicate that a wide range is possible, values from 50,000 to 850,000 having been obtained.

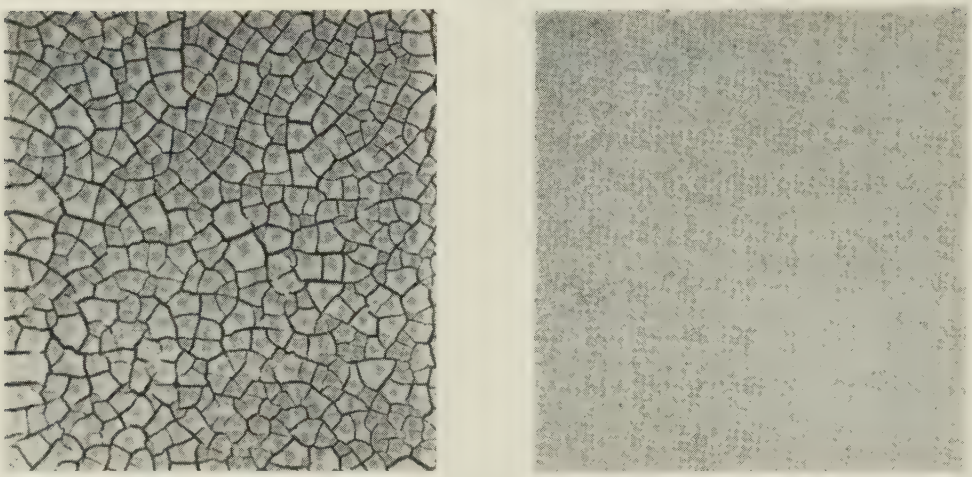

Figure 3. Films prepared by drying graft latices. Normal graft in the left hand photograph shows cracks in the film. Graft prepared by aeration polymerisation, on the right hand side, clearly shows much improved film forming characteristics.

Degradation and Cross Linking

Our earlier work has shown that natural rubber latex on storage and more particularly on aeration develops active centres giving reactions resembling peroxides. These centres are capable of polymerising vinyl monomers and of inducing chain scission at higher temperatures. They also give rise to cross linking of rubber molecules in the presence of suitable reducing systems such as polyamines. It is possible that these reactive centres are those responsible for the changes, hardening (cross linking) and degradation, which take place during shipment and storage of commercial rubber.

Since it is obviously an advantage to be able to control these changes, a study of the processes involved has been undertaken.

Preliminary observations show that aerated rubber which has been cross linked with a polyamine undergoes still further cross linking when heated at 140°C *in vacuo* in the presence of phosphorus pentoxide, thus indicating that all the reactive centres have not reacted with the amine. Rubbers from latex collected and dried under nitrogen still undergo hardening on heating *in vacuo;* this suggests that active centres are already present in rubber whilst in the tree. On heating in air, however, rubbers collected under nitrogen show superior resistance to oxidation compared with rubber collected normally. These facts together with other observations suggest that the problem is rather more complex than was at first supposed; the possibility that the reactions involved may be initiated by different types of reactive centres in the polyisoprene molecule should be borne in mind.

Thiol Acid Rubber (Anticrystallising or Low Temperature Rubber)

Experience at the B.R.P.R.A. has shown that the reaction between rubber hydrocarbon and thiol benzoic acid is inhibited by certain unknown substances naturally present in latex. To develop anticrystallising properties in rubber by this reaction it was necessary to use purified latex (twice centrifuged) which resulted in a costly

product. Work in Malaya has now led to a process in which rubbers with good anticrystallising behaviour can be obtained from field latex provided the naturally occurring inhibitors are first rendered inactive by treatment with formaldehyde. This process is much cheaper to operate.

A second difficulty experienced with thiol acid rubbers is low Mooney viscosity. Attempts to overcome this by hardening with peroxide/amine cross linking produced a harder material, but only slight retardation of crystallisation was obtained. Further work on this problem is in hand.

Superior Processing Rubber

Earlier work, described in the previous *Annual Report*, developed a concentrated form of processing aid for natural rubber which on mixing with any grade of raw rubber conferred superior processing properties. Difficulties have been experienced with this concentrate or masterbatch, since during shipment and storage it was found that changes occurred which rendered the material difficult to disperse in rubber stocks by blending in a Banbury mixer. This behaviour has been traced to slow vulcanisation occurring in the raw rubber matrix of the concentrate. Experiments indicate that it can be circumvented either by using sulphuric acid as a coagulant in place of the formic acid previously employed, or by the addition of benzoic acid or certain other retarders of vulcanisation. Small shipments of the

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where is the drying time and T the absolute temperature, C being a constant. This relationship suggests an activated diffusion mechanism. The drying time from 5% downwards is also dependent upon relative humitidy, increasing with increasing humidity by about the same proportion at all temperatures.

The effect of thickness on drying time is variable; on average, drying time is proportional to the square of the thickness. No trends resulting from changing temperature or humidity are apparent. The equilibrium water absorption however is higher for thick sheet, and the raw rubber ageing characteristics are better, both observations probably being associated with the greater removal of non-rubber constituents from thin sheets during preparation. High humidities as well as decrease in thickness reduce the susceptibility to blister formation.

It has been found that dry sheet is not homogeneous across a given section. As drying proceeds, water diffuses to the surface and non-rubber materials diffuse towards the middle of the sheet. Because of this transfer the equilibrium moisture

content of the middle of the sheet is greater than that of the outer layers. It appears unlikely therefore that concentration of water based on the rubber phase can be the driving force causing diffusion of water outwards. This is much more likely to be associated with concentration of water based upon the non-rubbers. Other observations, including the shape of the drying curve and the temperature coefficient of drying, also suggest that vapour pressure of the solution of non-rubbers is a better measure of the driving force.

Observations made from ancillary experiments are also of interest. The vapour pressure isotherm of freshly prepared air dried sheet is found to be similar to that obtained by workers in consuming countries for smoked sheet. The water content increases almost linearly with vapour pressure up to about 55% relative humidity, but thereafter increases much more rapidly. The results do not conform with Raoult's Law.

Factors affecting dimensional changes during the machining and drying of coagulum have also been studied and the contribution of each assessed. As well as relaxation of machining stresses and loss of water, other factors such as size and shape of the sheet, the method of supporting it and temperature of drying have been shown to have a measurable influence on the dimensions of the dry sheet finally obtained.

APPLIED RESEARCH

LATEX TECHNOLOGY

Effect of Manuring upon Latex Properties

Studies have been commenced on the effect of manuring on the properties of latex yielded in large-scale fertiliser experiments on two estates. The trials are being carried out in co-operation with Soils Division and have been laid down to determine the influence of manuring upon the trees in general, the effect upon latex properties being an additional observation.

In one trial, pre-treatment collections showed the different plots to be very variable and not ideal for the experiment proposed. Even so, it is hoped to obtain some useful information from the observations. The first post-treatment collections have now been made, but the data have not yet been subjected to statistical analysis. No obvious trends are apparent at present.

Pre-treatment collections from the second trial indicate a much more even stand of trees. Manuring on this estate will not be undertaken until early in 1959.

Preservation with Boric Acid

It has already been reported that boric acid concentrates, although generally found promising, have been said to suffer from two defects: poor ageing of the raw film, and sporadic development of large bacterial populations leading to high KOH numbers.

Further work on the first of these problems has led to the conclusion that it does not constitute a grave defect, since it was found difficult to substantiate the complaint clearly.

Work on the second problem has shown that of the additional bactericides examined, selenium dimethyldithiocarbamate, zinc oxide, the zinc salt of mercaptobenzthiazole and sodium pentachlorphenate are all reasonably effective in reducing the development of bacterial contamination when added to ammonia/boric acid latex at low concentrations. Work is in hand to evaluate the foam-forming characteristics of these latices and further trials in consuming countries will obviously be desirable before any firm recommendation can be made with regard to commercial production.

New Preservative Systems

Many new preservative systems have been examined in screening trials designed to select the most effective in preventing bacterial contamination. In all cases a low ammonia content has been employed, and many of the systems are based on ammonia/boric acid or ammonia/zinc oxide, to which a small proportion of a tertiary bactericide is added. Patent protection for some of the systems has already been sought and others which are promising will be covered shortly. Trials have yet to be undertaken to assess the suitability of these latices for foam production and other latex applications.

Application has been made for patent protection of latex concentrate containing 2.2′ thio-bis-(4,6 dichlorophenol), a proprietary material which has been found to have a powerful bactericidal effect in latex.

Bacterial Contamination

Work on the use of bactericidal washes in latex factories to reduce the number of viable bacteria present in concentrate has already been described. It is apparent however that once bacterial contamination has occurred, irreversible changes can take place in the latex, with harmful effects.

An attempt has therefore been made to demonstrate to what extent contamination is harmful by reducing the number of bacteria occurring in field latex. Trees were fitted with covers over the tapping cut to keep it clean, the cut itself swabbed with an antibiotic dressing and the latex collected through clean metal spouts into shaded sterile bottles. Preliminary results show that a substantial reduction in bacterial count was obtained (30: 1) and that properties of concentrate prepared with the cleaner field latex were superior. These findings have now to be confirmed and extended.

Foam Rubber

The facilities available for foam rubber production and testing have been improved to bring our methods into line with current practice in Great Britain. A laboratory has been built where conditions of humidity and temperature can be controlled. A new and more accurate compression modulus testing machine has also been constructed.

Experimental work with boric acid systems has shown that this preservative has a small but definite effect upon vulcanisation of dried films in mercaptobenzthiazole formulations, causing a decrease in modulus and a less marked drop in tension strength. It may therefore be desirable to modify vulcanising formulations to suit boric acid latices when they are used for foam rubber production.

A systematic comparison of variously preserved low ammonia latices has now begun with a view to assessing curing rates, processing characteristics and foam rubber properties.

RUBBER TECHNOLOGY

During most of the year the post of Rubber Technologist was vacant and the work was supervised by the Officer-in-charge of Technically Classified Rubber. In consequence few investigations could be undertaken and the staff was occupied largely in routine testing.

Control of Vulcanising Behaviour

The possibilities of modifying the vulcanisation characteristics of sheet rubber by the addition of formaldehyde to the latex before coagulation have been further examined. The increase in strain values given by formaldehyde treatment has been confirmed, but the increment obtained is variable and does not appear to be related to the strain value itself. Formaldehyde was found to be less effective when ammonia was used in the field as an anticoagulant.

Preliminary tests indicate that the effect of formaldehyde upon stress and strain properties at higher elongations (i.e. 660% compared with about 100%) may be less marked.

Correlation of Normal and Rapid Strain Tests

Statistical analysis of over 600 results has shown that the established relation between normal and rapid strain tests does not hold for rubbers which have been prepared with cetyl pyridinium bromide (Fixanol) in order to modify their vulcanising characteristics. Departure from the accepted conversion plot is small, but is sufficient to warrant further investigation. Similar discrepancies in vulcanising characteristics have previously been observed in rubbers containing more non-rubbers than customary, e.g. rubbers coagulated at high dry rubber content and those containing additions of latex skim.

Extrusion Testing

The Shaw extrusion machine was installed and tests carried out to establish working conditions.

Comparisons were then made between the behaviour of SP rubbers in this extruder and in the piston extruder which has been used in control tests for SP rubber preparation. Extrusion swell measurements were lower with the Shaw extruder. Work is now in hand to produce quantitative data for the behaviour of SP, RSS and RSS compounds in extrusion. Such information should be of considerable interest to consumers of natural rubber (Figures 4 and 5).

Statistical analysis of collected data has shown that there is a highly significant correlation between the two test methods, developed by the R.R.I. and the B.R.P.R.A. respectively, for assessing the SP characteristics of rubber. The first test employs simple piston extrusion and measures swell, the second determines shrinkage after milling. The spread of the mill shrinkage data however is too wide to permit of its application to routine testing of SP rubbers. Experiments are in hand to investigate whether more precise data can be obtained by modification of the test procedure.

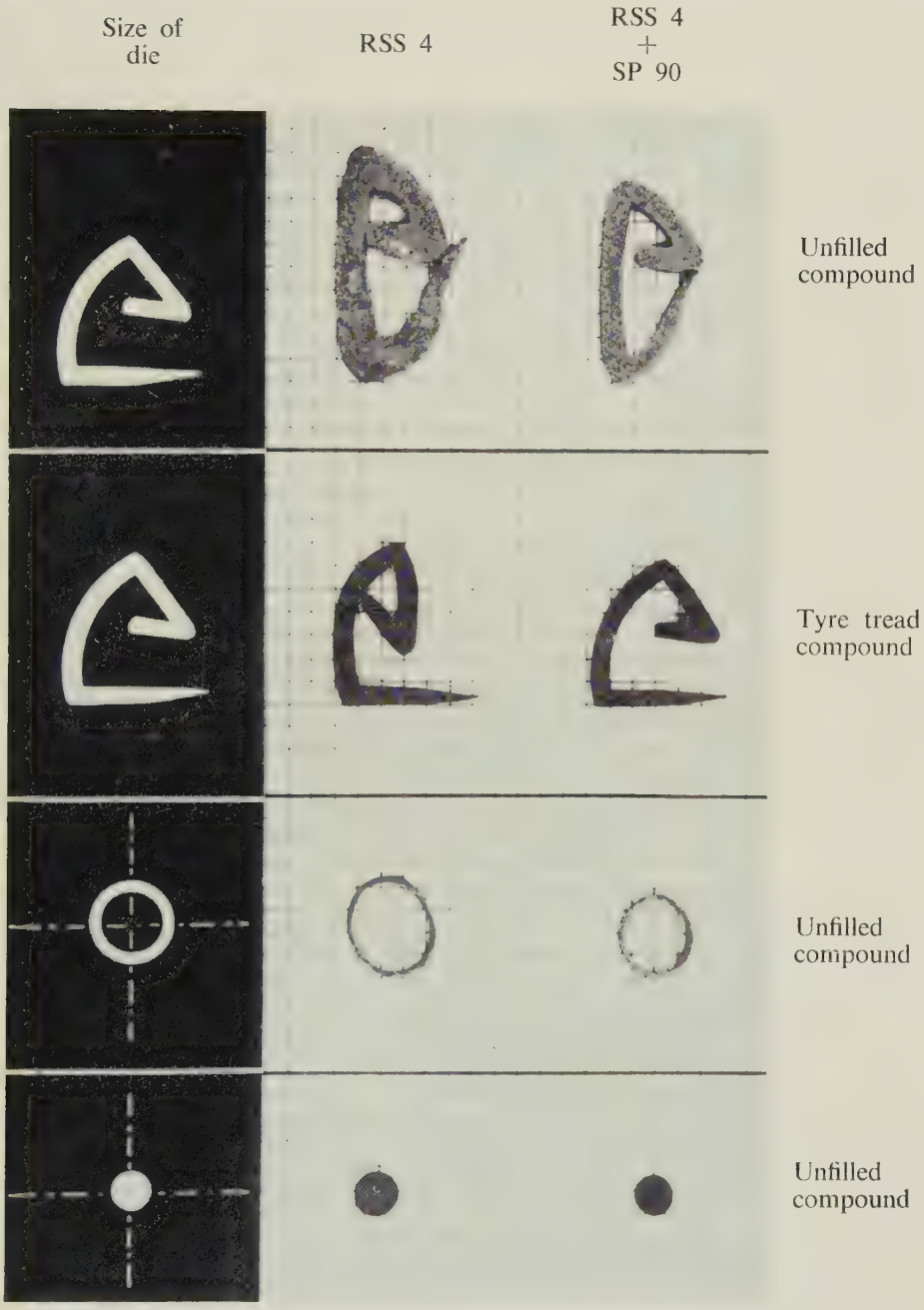

Figure 4. Photographs of extruded sections of rubber stocks showing improved conformance to die shape and die size when SP 90 is added to a lower grade rubber. Each side of a small square represents 0.5 cm.

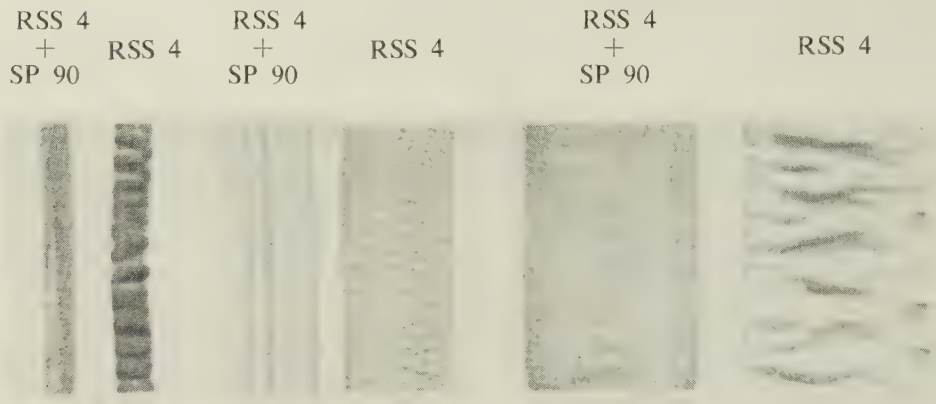

Figure 5. Photographs of extruded rubber stocks, showing marked improvement in surface smoothness when SP 90 is added to a lower grade rubber.

PROCESS EVALUATION

Effluent Disposal

Construction of the full scale plant for effluent disposal was started in May at the Experiment Station, Sungei Buloh. The plant has been completed and preliminary trials with effluent from sheet production in the factory are under way. When operating conditions have been fully established it is proposed to examine its efficiency in dealing with different types of effluent.

The full scale plant employs a trickling filter which utilises biochemical oxidation to break down offensive compounds to simpler innocuous molecules. Other methods for dealing with factory effluents have been studied in the laboratory. These have included neutralising the effluent followed by aeration, treatment with lime to precipitate sulphate, flocculation with aluminium sulphate and ferric chloride, and filtration through beds of different materials.

No single process was found to be particularly effective, but useful information has been gained and some of the processes will be used in conjunction with the trickling filter, as the situation demands. Thus a flocculating stage is at present being used at Sungei Buloh before the effluent is passed through the filter bed.

Of the different types of effluent examined that from skim serum was found to cause most pollution. The biochemical oxygen demand is high, falling between 6,000 and 18,000 p.p.m.; this together with a high ammonium sulphate content renders it a particularly polluting effluent.

The possibilities of segregating effluents obtained from different operations in the factory have also been briefly considered. Thus in some cases washings from latex concentration plant and equipment may usefully be treated separately, and the rubber recovered by addition of calcium chloride or acid. Of the two, acid treatment was found to be more efficient and considerably cheaper, relative cheapness increasing with higher dilutions of the washings. Such a stage in disposing of factory waste not only eases pollution problems but recovers a relatively pure rubber. The latter readily oxidises, however, probably owing to removal of

naturally occurring antioxidants, but with suitable treatment it should not be difficult to find a market for it.

Dehydration of Skim Serum

An alternative method for the disposal of some effluents is their utilisation as a nitrogeneous fertiliser. Skim serum is useful for this purpose, but the handling of large quantities of so dilute a material is usually inconvenient and expensive.

A short programme of work was undertaken to examine means of dehydrating skim serum to a more concentrated and easily transported form. Using a laboratory size spray drier it was found possible to produce solids in the form of a light brown coarse powder. Yields were low, about 60% of the calculated quantity, and the product was at times somewhat sticky. Pre-concentration of the skim serum by factors of 2, 5 and 10 using direct evaporation enabled higher outputs to be obtained, but invariably gave a sticky product and reduced the yield by half.

It is probable that operation on a larger scale would eliminate these difficulties, but even so the cost appears to be high. Under the most favourable conditions (tenfold concentration in a triple effect evaporator, 85% efficiency and spray drying, 100% yield) the cost of operating alone is approximately $160 a ton, whilst the value of the product is probably about $75 a ton. In addition there is the relatively high cost of the evaporator, spray drying plant and ancillary equipment. Straightforward concentration in a jacketed pan yields a brown sludge which can be handled quite readily, but the operating costs of a large scale plant would be just as high. It is apparent that as a commercial project production of dry fertiliser by such means will not be economic unless of course, disposal of the effluent by other means proves to be more costly.

The possibility of utilising solar heat to concentrate serum has not been ignored, but preliminary trials are not regarded as promising.

SP Brown Crepe

The use of a concentrated form of superior processing rubber with factory scrap to produce an SP brown crepe has already been reported. Further work has demonstrated the feasibility of operating such a process on a commercial scale, and ten tons have been successfully manufactured in our factory at Sungei Buloh.

Wet SP concentrate coagulum is milled into scrap rubber on macerator rolls. It is preferable first to mill the concentrate and the scrap separately to give loose crepes and then to blend them by milling together. The conditions under which the latex is vulcanised before the SP concentrate coagulum is made have an important bearing on the readiness with which the latter can be blended with the scrap. An excess of vulcanising ingredients gives rise to considerable difficulty in crepeing; a deficiency leads to easy crepeing but confers poor SP characteristics on the brown crepe finally obtained. The duration of vulcanisation can be increased without effecting crepeing but if reduced below a certain level gives poor SP characteristics. Thus some care must be taken to control the operations involved if a successful product is to be obtained. Large scale trials are now almost completed and it is hoped to release the process for commercial development very soon.

Heveaplus MG 50

Small quantities of rubber methyl methacrylate grafts have been prepared in response to requests from consumers. Since large scale production had not been established in Malaya, some time was devoted to bench experiments designed to determine factors important for scaling up the MG 50 process. Changes in the temperature/time curve during the reaction stage have been shown to effect the crepeing of the product. This is thought to be connected with the amount of monomer remaining unchanged in the graft. Pilot plant studies have now led to standardisation of reaction conditions; coagulation and crepeing techniques are still being studied.

Design of Drying Houses

Observations made during the investigation of factors affecting the drying of rubber coagulum have indicated that there is an economic optimum level of relative humidity for the drying air. Since drying proceeds more rapidly at low humidities, such conditions should be aimed at for efficient operation. On the other hand reducing the humidity increases the amount of ventilation and hence the fuel required to heat the air. Again the higher the humidity the larger is the drier required for a given output, and the greater is the surface from which heat losses can occur. Optimum humidity thus depends also on the level of insulation provided.

An attempt has therefore been made to assess what is the level of insulation at which the extra capital involved in reducing heat losses is balanced by saving in fuel costs. Calculations have shown that at the temperatures at present in commercial use (about 140°F) a heat transfer resistance of about 10 square feet per hour per degree F per B.th.u. is an economic level of insulation. In the majority of existing driers insulation falls below this standard and in many cases could be increased with advantage.

Experiment Station Factory

During the first part of the year the factory continued to prepare SP rubber to provide supplies when demands could not be fulfilled by commercial producers. The output was as follows:

SP Rubber Production at R.R.I.E.S. Factory in Tons

SP RSS	160
SP pale crepe	0.25
SP brown crepe	11.5
SP 90	1.3

Trials with an oil fired drier which utilised products of combustion direct and thus avoided the use of a heat exchanger, showed that satisfactory pale crepe and ADS could be produced in this way. The increase in efficiency is considered to be small, however, since the proportion of hot air which can be recirculated through the drier is limited by the high water content of the products of combustion, which increases the humidity and thus increases the drying time required.

ADVISORY WORK

The advisory Officer, Mr J. E. Morris, continued to supervise the work of the Analytical Section in addition to operating the Advisory Service of the Division; in his routine he has also included visits to estates participating in the Technical Classification scheme, and has assisted with problems arising in the course of preparing and marking the rubber.

The volume of enquiries from estates and factories remained at much the same level as in previous years, as shown by the office records below.

	Letters received		*Letters despatched*	
	1957	*1958*	*1957*	*1958*
Sheet rubber production	262	318	328	368
Crepe rubber production	357	271	412	284
Latex production	849	778	1,330	1,154
Other processes	287	570	428	715
Technical classification of rubber ...	1,307	1,537	659	830
Research and other matters	605	661	809	806
	3,667	4,135	3,966	4,157

The number of advisory visits and interviews increased.

Visits :

	1957	*1958*
Advisory	183	236
Experiment Station	561	516
Research and other matters	44	73
Interviews	298	443
Lectures	2	1

Samples examined :

Latex hydrometers	73	62
Customs	455	590
Latex	1,223	1,053
Sodium bisulphite	2	5
Coagulants	2	3
Defects in sheet and crepe	244	361
Cyclised rubber	259	119
SP rubber	228	938
T.C.R.	21,280	22,235
Others	233	259

Sheet Production

During 1958 there has been an increased interest in the production of sheet rubber. This has arisen from a number of causes, one of which was the recession in the market price of latex concentrate. To enable latex concentrate production to proceed economically, lower prices were offered to estates supplying the field latex; the price difference increased from the customary figure of three cents below RSS 1 to as much as six cents. Since it is usually not economic for estates to sell liquid latex when the price difference is greater than three and a half cents, many have undertaken sheet rubber production in preference. This has resulted in requests for advice on the reception and handling of latex and on factory planning for sheet production.

Other factors influencing the increase in sheet production were the larger harvests obtained as a result of high intensity tapping, the use of yield stimulants and the quantity of young, high yielding trees coming into bearing. These latter factors have also given rise to many enquiries regarding sheet defects, all of which can be readily overcome by adoption of the required precautions.

Changes in the type of latex harvested have also affected the Technical Classification of rubber on some estates and advice has been given on the procedures necessary to cope with the changes experienced.

There has been a marked increase in the number of oil-heated, air-circulating drying tunnels in commission; about sixty are now in operation throughout the Federation. The tunnels usually accommodate twelve trucks of the R.R.I. Smokehouse Type B pattern, and can dry four thousand pounds of rubber a day. They have supplied a definite need on estates where firewood is not readily available. The use of somewhat higher temperatures in the tunnels requires more attention to the preparation of the sheets, and it is important to ensure thorough mixing of acid and latex in the coagulating tanks, if bubbly sheet is to be avoided.

Increased crops have resulted in smokehouses being used to capacity and have thus brought to light any deficiencies occurring. Much work has been done to improve the efficiency of heat transfer and air circulation. The R.R.I. type furnace, provided it has adequate secondary air, has again been found superior to the old brick-arch type. It is recommended that when replacements of the old type become necessary, consideration should be given to introducing the R.R.I. metal-arch type furnace. Further observations on the use of R.R.I. type smokehouses on sites where the water table is high have confirmed that their operation is very satisfactory when the furnace is raised to ground level.

Crepe Rubber Production

Crepe rubber production was at a low level during the first half of the year, and most estates having alternative processing facilities made full use of them. Production increased slowly during the latter half of the year but pale-crepe was still fetching only a small premium. The volume of enquiries received concerning crepe has in consequence shown a decrease.

Among other matters, enquiries have dealt with the use of bleaching agent to treat whole latex crepe, thus avoiding the loss due to fractionation, and with the suitability of different clonal rubbers for preparing a good hard crepe.

In localities where the rubber produced tends to be a little soft, or where considerable areas of young rubber are coming into tapping, particularly soft clones such as RRIM 501, PR 107 and LCB 1320, considerable difficulty has been encountered in producing crepe with a good colour. This is due partly to inability to use much Emulsion A for bleaching, for fear of making the crepe oversoft, and partly to the naturally more yellow colour of latex from young trees. We wish to emphasise once again that not more than sixteen ounces of Emulsion A concentrate per thousand pounds of rubber should be used for treating whole latex. In the case of latex from which a first fraction has been removed, not more than six ounces per thousand pounds of rubber should be added. If adequate bleaching is not obtainable with these quantities, it is recommended that the R.R.I. is requested to carry out tests to assess the optimum amount to give both good colour and adequate hardness.

Not many complaints have been received regarding defects arising from inadequate drying of pale crepe, such as spot disease and discolouration. This may be taken to indicate greater care and efficiency in the operation of drying houses. Correspondence regarding sole crepe has centred around colour and lamination defects.

Following the observation made in the laboratories that discolouration of rubber can be brought about by certain amines naturally occurring in rubber, it has been suggested that formaldehyde or oxalic acid should be used as a means of preventing discolouration since these reagents react with some amines and render them inactive. Replacement of one-fifth of the formic acid normally used for coagulation by oxalic acid has been found beneficial in some instances.

Latex Concentrate

1958 proved to be a record year for latex concentrate, about 115,000 tons being produced; even so the price has not been so attractive as formerly, and only a small premium over RSS was obtained.

One of the major changes in production is the increased interest in latices having low levels of ammonia and a secondary preservative. Most of the low-ammonia type production utilised sodium pentachlorphenate, zinc diethyldithiocarbamate or boric acid as the secondary preservative.

In general, a high level of quality in all types of latex concentrate has been maintained throughout the year and most of the advice sought has dealt with cleanliness and efficiency of factory operation, and methods of producing the new types of concentrate.

Effluent Disposal

Problems arising from disposal of factory effluents have become increasingly apparent during the year. Difficulties have arisen chiefly in connection with factories producing latex concentrate, but the problem does not appear to be confined solely to such effluents. At the close of the year seven cases had been examined in which complaints of pollution had been received. The problems presented were of an individual character and no general solution was possible. Advice had thus to be matched to the particular problems which arose.

Our view is that the use of the trickling filter is probably the best means of purification available, but until we have had experience in treating different types of effluent by the trickling filter just installed at our Sungei Buloh factory, we hesitate to advise its adoption. The use of skim serum as a fertiliser should not be ignored as a convenient means of disposal, when circumstances permit.

Special Rubbers

Cyclised rubber. Small quantities of cyclised rubber have been produced commercially and the Division has continued to carry out quality control tests on production samples received. Over one hundred samples were examined representing a little over forty tons of cyclised rubber produced.

Superior Processing (SP) rubber. There has been a marked increase in the production of SP rubber during the period under review. Shipments during the first quarter totalled 139 tons, whereas during the last quarter the amount was 437 tons. Shipments for the whole year totalled 1,139 tons. Most of the rubber was produced by commercial companies, four of which were in production at the close of the year, the R.R.I. by that time having ceased production of current commercial types. Our laboratories have carried out quality control checks on all production lots. Time has also been devoted to advising on production and to arranging contacts between prospective customers and producers.

In large scale operation it has been observed that temperatures up to 160°F can be used for drying with no deleterious effect upon the superior processing characteristics. The use of higher temperatures, however, causes the colour of the product to darken.

Emulsion A concentrate has been used successfully to bleach SP crepe and air dried sheet.

Partially purified rubber. Some interest has been shown in purified rubber prepared according to a simple R.R.I. process in which centrifuged latex is coagulated at low d.r.c. and processed as crepe.

Small quantities of the material have been produced commercially for consumer evaluation, the Division advising on production methods and carrying out quality control tests on the finished material.

Technical Classification

The number of estates participating in the scheme for Technical Classification of rubber fell to 83 in January but increased slowly throughout the year to 92 in December. Classification on most of the estates has been carried out using the established quality control chart method, but four estates worked satisfactorily throughout the year on the basis of classification by lot.

Details of estate production in the Federation of Malaya and British North Borneo are as follows:

ESTIMATED OUTPUT OF RUBBER FROM ESTATES USING R.R.I. FACILITIES FOR TECHNICAL TESTING, TOGETHER WITH SOCFIN PRODUCTION*

Type of rubber	Technical Classification — In long tons			
	Red Circle	Yellow Circle	Blue Circle	Total
RSS 1	886	18,509	6,141	25,536
RSS 2	—	452	—	452
Brown crepe	—	311	—	311
Pale crepe	550	—	—	550
Clippings	—	107	—	107
ADS	738	893	198	1,829*
Total	2,174	20,272	6,339	28,785

* Socfin production comprised 1,829 tons ADS

The estimated output from estates, 28,785 tons, compares favourably with the figure for 1957 of 27,236 tons. The actual production in 1957 was 26,347 tons.

Details of actual production from packing houses are as follows:

RUBBER FROM PACKING HOUSES CLASSIFIED AT R.R.I.

Type of rubber	Technical Classification — In long tons			
	Red Circle	Yellow Circle	Blue Circle	Total
RSS 1	7.8	399.6	211.9	619.3
RSS 2	Nil	15.0	45.0	60.0
RSS 3	Nil	15.0	55.0	70.0
ADS	10.0	5.0	70.0	85.0
Total	17.8	434.6	381.9	834.3

The total production of 834 tons was produced by six different packing houses and is at about the same level as for 1957, when 765 tons were classified.

The estimated total production of TC rubber for Malaya and British North Borneo is thus 29,619 tons, which is a little higher than the estimate of 28,001 tons for 1957.

The Division has continued to act as co-ordinator under the auspices of the International Rubber Research Board (I.R.R.B.), for technical matters arising in connection with the application of TC in other producing territories. Laboratory cross-checks have been organised between the different test stations and reports on world production of TC rubber prepared for the I.R.R.B.

W. G. Wren
Head of Chemical Division

Smallholders' Advisory Service

Since its formation in 1934 the Smallholders' Advisory Service has received assistance in the form of supervision of its field staff by officers of the Department of Agriculture in the various States. While general instructions and guidance on all technical matters were provided from the Institute, each Agricultural Officer in charge of a state or circle was responsible for the day-to-day supervision of the work of S.H.A.S. staff in that area.

The assistance of the Department of Agriculture was particularly valuable during the early years of the Service when the field staff was too small to justify the appointment of a full-time officer to control the Service from the Institute. As the Service developed over the years, numbers increased: first a Smallholders' Advisory Officer and later Assistant Advisory Officers were appointed. Once these appointments were made, the continued assistance of senior field officers of the Department of Agriculture introduced an element of dual control which was at times confusing to Rubber Instructors. This was agreed to be undesirable and when the senior staff at S.H.A.S. headquarters was increased to four during 1958, a new arrangement was made whereby all work by field staff of the Service is to be supervised direct from the Institute.

It continues to be of major importance that the Smallholders' Advisory Service should work in close accord with the Department of Agriculture. This was provided for in a memorandum, agreed by the two organisations, detailing the responsibilities of each to rubber-growing smallholders. This memorandum was sent to all staff of both organisations and its provisions put into effect from 1 December 1958. Our appreciation of the assistance of the Department of Agriculture over 24 years is recorded, with the assurance that close co-operation in matters of mutual interest will continue.

The Service also co-operates closely with the Rubber Industry (Replanting) Board and a separate memorandum was drawn up detailing the methods whereby these two organisations should meet their respective responsibilities. The memorandum was agreed but not distributed. It will be put into effect early in 1959.

Headquarters Staff

Mr L. R. Davidson, Smallholders' Advisory Officer, was on long leave from 1 February to 3 October. On his return to duty Mr Davidson left the Smallholders' Advisory Service to become the Head of the new Estates Advisory Service. Mr J. M. F. Greenwood was appointed to act as Smallholders' Advisory Officer from 1 February and continued in this appointment at the end of the year.

'Che Shamsuddin bin Yub Ahmad, Assistant Smallholders' Advisory Officer, was seconded to the Federal Land Development Authority from 1 April to take up a position as Secretary/Executive Officer for a trial period of one year. During this period it will be decided whether 'Che Shamsuddin is to remain permanently with the Land Development Authority or to return to his appointment with the Smallholders' Advisory Service.

Mr J. G. Samuel, Assistant Smallholders' Advisory Officer, was on duty throughout the year.

'Che Mohd Johar bin Mohd Rashid, Senior Rubber Instructor for Kelantan and Trengganu, attended a short course at the Co-operative College, Petaling Jaya, from 9 to 19 March. The course was designed for Government Officers interested in the application of co-operative principles in Malaya. He was transferred to Headquarters on 25 April and on 1 August was promoted Assistant Smallholders' Advisory Officer, Division B. 'Che Mohd Johar left on five months long leave from 16 December.

Mr Wong Mun Yun, Senior Rubber Instructor for Negri Sembilan and Malacca, returned from long leave on 8 October and was posted at Headquarters.

Mr A. Chelliah, Field Assistant, was on long leave from 10 February to 11 May and Mr K. Vepaneswaran accepted temporary appointment to undertake supervision of labour at the Ulu Klang smallholding and nurseries during Mr Chelliah's absence. Mr Vepaneswaran was employed from 29 January to 31 May.

'Che Mohd Noordin bin Jantan, headquarters clerk, was on long leave from 4 June to 19 September, during which period Mrs N. Soars was temporarily transferred from the Publications Section to assist with clerical work. 'Che Mohd Noordin interrupted his long leave from 12 to 27 August to undertake a special assignment.

Rubber Instructors

Three R.R.I. scholars completed the diploma course at the College of Agriculture and were appointed Rubber Instructors on 1 May 1958. These men were posted for field training, and after eighteen weeks with an experienced Rubber Instructor attended a three-month training course with Junior Rubber Instructors at the R.R.I. Experiment Station. At the end of the course the new Rubber Instructors were posted to stations as follows:

'Che Ahmad Mahidin bin Ulong Sha'aban to Seremban
Mr Phang Ah Kow to Klang
Mr Soh Ah Leng to Bentong

One Malay Rubber Instructor resigned on 15 June to take up appointment with the North Kedah Land Development Board as Manager of the Sungei Tiang Land Development Scheme.

One Indian Rubber Instructor resigned from 1 October and the second Indian Rubber Instructor went on long leave from 8 December. He will not be returning to the Service after his leave.

There were twenty Rubber Instructors in the Service at the end of the year. This number is not sufficient to undertake the work expected of the Service and every effort will be made to recruit additional Instructors, despite competing demands from other organisations for similarly qualified men.

Six Rubber Instructors took long leave during the year.

'Che Mohd Piah bin A. M. Aras ... ... from 1 January to 13 April
Rubber Instructor, Tampin

Mr Chang Seng Kiat ... ... ,, 1 April to 2 July
Rubber Instructor, Sg. Patani

'Che Mohd Shafii bin Hj. Ludin ... ... ,, 2 April to 16 August
Rubber Instructor, Klang

Mr Wong Mun Yun ... ... Senior Rubber Instructor Negri Sembilan/Malacca	from 1 May to 7 October
Mr Tan Poh Hock ... ... Rubber Instructor, J. Bahru	,, 1 July to 4 October
'Che Mohd Noordin bin Ahmad ... ... Rubber Instructor Kelantan/Trengganu	,, 8 November

It was not possible to provide temporary replacements for Rubber Instructors on long leave and our work in the districts concerned was continued by Junior Rubber Instructors working with a minimum of supervision from Kuala Lumpur.

The promotion of two Senior Rubber Instructors together with the resignations of three Rubber Instructors made a number of transfers essential. Eight Rubber Instructors were transferred to new stations.

'Che Ahmad Hamidy bin Mohd Zam	from K. Trengganu to Jitra on 27 Feb.
Mr Lim Hong Hai	,, B. Pahat to Seremban on 23 April
'Che Mohd Noordin bin Ahmad ...	,, Taiping to Machang on 1 May
Mr Lee Buck Heng	,, Kuantan to B. Pahat on 6 May
'Che Kassim bin Hassan	,, Tapah to K. Kangsar on 4 Aug.
'Che Mohd Shafii bin Haji Ludin ...	,, Klang to Temerloh on 2 Sept.
Mr Chen Chen Chuan	,, Raub to Kajang on 20 Oct.
Mr Chin Kai Ming	,, Kajang to Kuantan on 20 Oct.

These transfers left the stations of Kuantan (temporarily) and Kuala Trengganu (permanently) without a Rubber Instructor. Until the staff position improves, the work in Trengganu will be undertaken by Junior Rubber Instructors working under the supervision of 'Che Mohd Noordin bin Ahmad at Machang in Kelantan.

One Rubber Instructor, in hospital at the beginning of the year, was on medical leave until 10 March when he returned to light duties at his station. He was later passed as medically fit and resumed his normal duties.

Junior Rubber Instructors

The Blackman Committee has recommended that every effort should be made to promote the effectiveness of the Smallholders' Advisory Service, particularly in view of heavy additional demands for advice arising from the increase in smallholders' replanting and in the development of new plantings. To enable the Service to meet its responsibilities a considerable staff is essential. It is not possible to increase the staff of Rubber Instructors rapidly and the alternative is to employ larger numbers of Junior Rubber Instructors. In August the Board approved an increase in the establishment for this grade from forty-two to ninety.

Junior Rubber Instructors are of School Certificate standard on appointment and are trained at the R.R.I. Experiment Station. One training course was held from 15 September to 6 December. Twenty-two candidates attended this course and at the completion of training seventeen were offered appointments from 1 January 1959. These appointments will increase the number of Junior Rubber Instructors employed to fifty-four but at 31 December there were only thirty-seven in the Service.

The course for prospective Junior Rubber Instructors was also attended by an officer of the Rubber Industry (Replanting) Board and five officers employed by the Federal Land Development Authority for training as management assistants for employment in new planting schemes.

Twelve Junior Rubber Instructors, appointed last year, completed periods of field training under experienced Rubber Instructors and were posted to their first stations.

'Che Abu Bakar bin Hj. Yacob	to Grik on 24 February
'Che Abd. Hamid bin Hj. Osman	,, Ijok, Selangor on 24 February
Mr Tan Kim Chooi	,, Slim River on 24 February
Mr Au Ah Sin	,, Kulim on 24 February
Mr Mong Sek Keong	,, Jasin on 24 February
'Che Kamaruddin bin Ariff	,, Segamat on 27 February
'Che Mohd Ardenan bin Hj. Ismail ...	,, Mersing on 29 February
Mr Teng Hock Phai	,, Jitra on 5 May
'Che Abu Bakar bin Hj. Ahmad	,, Kuala Pilah on 19 May
Mr Tan Soon Huat	,, Kluang on 12 June

'Che Abd. Bari bin Abd. Hamid remained at Taiping, and 'Che Abd. Ghani bin Abd. Rahman at Muar.

Two transfers were made: 'Che Baharuddin bin Dahalan moved from Jitra to Pendang in anticipation of the posting of a less experienced Junior Rubber Instructor to Jitra, and Nik Idris bin Nik Daud moved to Kuala Trengganu.

It is proposed to change the title from Junior Rubber Instructor to Assistant Rubber Instructor in 1959.

Rubber Demonstrators

It is not our policy to increase our staff of Rubber Demonstrators as this grade will be completely replaced by Junior Rubber Instructors in due course. Rubber Demonstrators, however, have a special value in isolated or inaccessible stations and one appointment was made during January for a Demonstrator to serve in Gual Periok, Kelantan. This appointment brought the number of Rubber Demonstrators to ten.

Recruitment and Training of Staff

There is an urgent need to recruit additional Rubber Instructors, both for direct advisory work and assistance in the field supervision of Junior Rubber Instructors. Rubber Instructors must, however, be men with a sound training in basic agriculture and only applicants holding the Diploma of the College of Agriculture are offered appointment. There is an acute shortage of trained agriculturists of this standard in Malaya and it has not therefore been possible to increase the cadre of Rubber Instructors except by provision of scholarships at the College of Agriculture. These in turn have been strictly limited by the intake capacity of the College. This year six places were allotted to R.R.I. scholars, and six scholarships were awarded for the session commencing 11 June, 1958. An additional scholarship was awarded to a student already at the College, bringing the number of R.R.I. scholars to a total of eleven. These men are expected to graduate, one in 1959, four in 1960 and six in 1961.

Four of the R.R.I. scholars studying at the College spent a part of their long vacation assisting in an extension project undertaken by the S.H.A.S. and were able to obtain experience of working among smallholders and in demonstrating the techniques of processing and smoking rubber.

Housing for Rubber Instructors

Quarters at Machang, Malacca and Sitiawan were completed and occupied, bringing the total of Rubber Instructors' houses to ten. House sites were obtained at Raub, Taiping, Johore Bahru and Kluang. Plans for houses at Johore Bahru and Kluang were in preparation while tenders were called for the building at Taiping and a contract awarded for building at Raub.

A house was built at the Ulu Chalok Land Development Scheme in Trengganu to enable a Junior Rubber Instructor to be posted there during 1959.

Field Visits by Senior Officers

A total of 161 working days was spent with Rubber Instructors and Junior Rubber Instructors by Senior Officers on routine visits. This represents 20% of the working time of officers at Headquarters and while this is considered adequate, it is hoped that the proportion of field work will be increased now that there is a permanent Headquarters staff of four officers.

Visitors from Abroad

Two Agricultural Officers from Burma spent the month of April at the R.R.I. Experiment Station and in making field visits with Rubber Instructors. Their main interest was to learn the technique of budgrafting but they also received training in nursery work and planting methods for smallholders.

Mr M. Soyander, of the Cambodian Water, Forests, Hunting and Fishing Service visited Malaya to study the smallholders' rubber industry. He spent the period from 18 October to 8 November with officers at headquarters, at the Experiment Station and making visits with Rubber Instructors in Perak, Negri Sembilan, Malacca and Johore.

A party of nine Government Foresters from Cambodia spent five days from 24 to 29 November with officers of the Service visiting the R.R.I. Experiment Station, land development schemes, central factories and smallholdings of interest.

Mr B. Aguanta, an officer of the Philippines Bureau of Plant Industry, spent eight weeks at the Rubber Research Institute of which ten days during July were spent with Rubber Instructors in Perak, Selangor, Negri Sembilan and Malacca.

Visitors from abroad received for brief periods included Sir Alexander Fleck, Chairman of I.C.I. London; Mr A. P. P. Campbell, Rubber Planting Officer, North Borneo; M. d'Auzac from I.R.C. Sud-Vietnam and Messrs G. Bailey, R. D. Kirk, J. A. Hendrick and N. Orr, of the Department of Agriculture, Sarawak.

Three students from the Department of Agriculture, Sarawak, and three from British North Borneo attended the course for prospective Junior Rubber Instructors.

Correspondence

A total of 6,708 incoming and 5,162 outgoing letters has been handled by the two clerks of the Section, an average of 989 letters per month.

ADVISORY

Planting

A total of 10,837 acres of new planting on individual smallholdings was reported by Rubber Instructors, 3,704 (34%) being with clonal seedling material. The rate of new planting thus remains very similar to that in previous years but the proportion of clonal seedling material used has dropped markedly. (Of 1957 new planting, 72% was reported as clonal seedling material). There is a general tendency towards the use of more budgrafted material, as can be seen from the Table below giving details of new planting in each State. Budgrafting of 4,075 acres of new planting is reported and this figure indicates that the majority of areas previously planted with ordinary seed have, in fact, been budgrafted. It is probable that some holdings planted with clonal seedling stumps have also been budgrafted.

NEW PLANTING REPORTED BY RUBBER INSTRUCTORS 1958

State	Total acres	Planted with clonal seedlings		Budgrafting on previous plantings, acres
		Acres	%	
Selangor	56	56	100	16
Negri Sembilan	1,224	454	37	11
Malacca	561	111	20	56
Perak	838	659	79	309
Johore	2,598	341	13	1,967
Pahang	544	535	98	1,140
Kedah/Perlis	2,231	1,032	46	351
Penang/P.W.	—	—	—	—
Kelantan	2,619	415	16	225
Trengganu	166	101	61	—
Total	10,837	3,704	34	4,075

In addition to new planting of rubber by individual smallholders considerable areas of new land have been developed by group schemes financed by loans from the Federal Land Development Authority or State Governments and supervised by State Land Development Boards.

Visits by Senior Officers were made to development schemes at Ayer Lanas, Kelantan; Ulu Chalok, Trengganu; Sungei Bilut, Pahang; Sungei Lui and Mah San in Negri Sembilan; and at Kemendore, Bukit Apit, Bukit Katil and Solok Menggong in Malacca. For each of the last six schemes listed, detailed recommendations for development were provided as a basis for planning by the local Land Development Board. Advice during the early stages of planning was provided directly by the Institute, rather than by Rubber Instructors, to ensure that knowledge available from the Research Divisions was fully utilised and that the advice was properly recorded. This provides for continuity in the event of Rubber Instructors being transferred. After a planting programme has been agreed in all its essentials a Rubber Instructor advises the Manager of the scheme on practical details and a Junior Rubber Instructor undertakes more detailed work among the settlers, providing practical demonstrations of each operation at the time when it is undertaken.

Smallholders have been purchasing considerable quantities of RRIM 600 Series budwood particularly for multiplication and later use on new plantings. During the year a total of 1,770 yards of these clones was distributed and details are shown in the Table.

RRIM 600 SERIES BUDWOOD SUPPLIED TO SMALLHOLDERS IN 1958, YARDS

Clone	Johore	Malacca	Perak	Selangor	Pahang	Kedah	Negri Sembilan	Kelantan	Total
600†	90	—	50	—	7	85	10	10	252
602	5	—	—	—	13	—	—	—	18
603†	63	—	80	—	3	51	—	—	197
604	—	—	—	—	—	14	—	—	14
605†	90	16	119	35	90	69	5	5	429
606†	48	—	21	—	3	11	—	—	83
607†	25	—	24	—	16	10	10	10	95
610†	12	—	12	—	2	45	—	—	71
612	27	6	105	—	2	—	—	—	140
613	2	—	22	—	—	—	—	—	24
614	20	—	69	5	6	62	—	—	162
615	1	—	34	—	—	38	—	—	73
618	—	—	—	—	—	7	—	—	7
621	3	—	—	—	—	—	—	—	3
623†	61	—	91	11	17	15	—	5	200
628	2	—	—	—	—	—	—	—	2
Total	449	22	627	51	159	407	25	30	1770

† At present the most promising clones; they account for 92.5% of total distribution.

As more information on these clones becomes available it has been possible to distinguish the seven most promising clones. Budwood sales to smallholders are now restricted to these clones. This is considered to be justified, as a smallholder with only a small area of rubber cannot afford to plant even a proportion of his holding with more speculative material. Most of the budwood of clones not

holding with more speculative material. Most of the budwood of clones not generally considered promising which has been distributed to smallholders (as shown in the Table) has, in fact, gone to owners of relatively extensive holdings which amount to small estates. Unlike the genuine smallholder, they can afford to experiment with speculative material on a small scale.

Field staff of the Service continued to devote a large proportion of their time to work with replantings, but no figures are reported as these can be provided more accurately by the Rubber Industry (Replanting) Board.

Tapping

The correct opening of young trees for tapping is of major importance if smallholders are to obtain full benefits from replanting. Advisory work on this subject has therefore been given a high degree of priority. Reports from field staff and observations made in different parts of Malaya indicate that it is usual for advice to be accepted and trees correctly tapped, but the tendency persists for smallholders to tap trees before they reach optimum girth. To check this as far as possible the Rubber Industry (Replanting) Board continued to provide Rubber Instructors with lists of all holdings receiving the final instalment of the replanting grant so that advisory visits could be made.

Rubber Instructors have continued to record the yields obtained on a sample of replanted smallholdings. The records are not yet sufficient to allow definite conclusions to be drawn but the indication is that yields from budgrafted rubber are satisfactory whereas yields from many clonal seed plantings are disappointingly low.

Manufacture

The sale by smallholders of latex for concentration or for the central manufacture of sheet continued at approximately the rate reported during 1957. One thousand one hundred and eighty-one tons dry rubber were processed centrally as sheet and 4,093 tons finally sold as latex concentrate. Smallholders' latex exported as liquid concentrate is, of course, sold initially to large producers who undertake the processing. The figures reported for the central processing of sheet, however, refer entirely to very small factories, organised and operated by smallholders themselves. They do not include the rubber processed by individuals working at central processing centres.

CENTRAL PROCESSING OF SMALLHOLDERS' LATEX, 1958

State	Collected for sale as latex, tons	Collected for sheet manufacture, tons
Selangor	1,672	340
Negri Sembilan	431	17
Malacca	—	14
Perak	613	188
Johore	1,377	378
Kedah/Perlis	—	244
Total	4,093	1,181

The system whereby individual smallholders or tappers bring latex to a central processing point but undertake the work of processing individually is considered to be the most acceptable and practicable first step towards fully centralised bulk processing. The system is popular among Chinese smallholders living in New Villages but has not been used by Malay smallholders. Considerable attention has therefore been given to this method of processing and Mr J. G. Samuel has been occupied mainly in this work. Following a general survey undertaken previously, an initial experiment was made at Kampong Sungei Marab Ulu near Kajang, Selangor. Here a temporary-type smokehouse was built and an existing factory shed improved so that a group of some twenty-seven smallholders could produce first quality smoked sheet. A separate report on this experimental project was distributed to those likely to be interested, particularly the Rural and Industrial Development Authority and the Department of Co-operative Development, as the assistance of these two organisations was expected to be needed by groups of smallholders establishing similar schemes.

A Group Processing Centre in Perak

The particular advantage of the group processing system is that individual smallholders process their own latex and are able to sell their sheet, after it has been smoked in the communal smokehouse, as and when they please. A minimum of organisation is required and no problems of transport, latex preservation, d.r.c. estimation or grading of sheet arise. The benefit to the individual is immediate and obvious and it is hoped that such centres will, in time, develop into central factories where latex is processed and sheet sold in bulk.

Rubber Instructors and Junior Rubber Instructors were given detailed information on the proposed organisation. As a result of their efforts five group processing factories were established in Selangor, Perak and Pahang and seven were in the course of establishment at the end of the year.

INFORMATION

Training Courses

As one method of making the most effective use of a limited staff working among a very large number of smallholders, more attention was devoted to organised training courses: instruction at three levels has been provided. Instruction was also given at Department of Agriculture courses.

Standard courses. The standard course, suitable for smallholders with education equivalent to Malay School Standard V, provided detailed practical instruction, with sufficient theoretical instruction for the students to understand the reasons for the procedures taught. The courses occupied either one month (during which students were resident at the Smallholders' School, Ayer Pa'abas, or at the R.R.I. Experiment Station) or one day each week over approximately six months when students attended at a centre near their homes. Written examinations and practical tests were held at the end of such courses and printed certificates awarded to successful students. Those completing the courses but failing the examination were given a typewritten certificate of attendance. Details of the ten courses provided are shown below.

The Smallholders' School at Ayer Pa'abas, Malacca.

STANDARD COURSES 1958

Location		Students enrolled	Completed training	Awarded certificates:	
				Number	Percentage
R.R.I. Experiment Station	(Chinese)	16	15	14	87.5
	(Malay)	39	39	31	79.5
Smallholders' School Ayer Pa'abas					
(i)	(Malay)	15	15	9	60.0
(ii)	(Malay)	18	18	12	66.7
(iii)	(Chinese)	25	25	10	40.0
(iv)	(Malay)	12	12	7	58.3
(v)	(Malay)	16	16	10	62.5
(vi)	(Malay)	21	21	12	57.1
(vii)	(Malay)	23	23	16	69.6
Tanah Merah, Kelantan	(Malay)	23	19	14	60.9
Total		208	203	135	—
Percentage		—	97.6	64.9	—

It was disappointing that a higher proportion of students, did not pass the examinations and obtain certificates. It is notable that results at the R.R.I. Experiment Station, where close supervision was possible, were better than at Ayer Pa'abas where courses were conducted by a Junior Rubber Instructor guided by a Rubber Instructor. In an effort to improve results, a detailed time-table was prepared for the final course at Ayer Pa'abas and is to be followed exactly in all future courses. While the number of certificates awarded is a measure of the success of the instructors at the school it must be remembered that some of the smallholders attending these courses did not have the basic education considered desirable and hence found it difficult to complete written examinations. In view of this an average pass of nearly 65% can be considered satisfactory.

Students attending courses were selected not so much on educational standard as on the use they were expected to make of the knowledge gained. Only smallholders, their sons or others intending to undertake rubber planting were accepted and every effort was made to exclude those seeking training only as a means to obtaining paid employment. The only exception made was for a very small number of students accepted on courses prior to leaving the armed forces.

At the end of the year all students who had attended courses at Ayer Pa'abas during 1958 were contacted by Rubber Instructors to discover what use was being made of the training. Of the 130 ex-students only 22 were in no way concerned with rubber growing. Numbers employed full time or part time in the rubber industry are shown in the Table and a proportion of 81.5% so occupied is considered to indicate that methods of selecting students are satisfactory.

STUDENTS COMPLETING COURSES AT AYER PA'ABAS 1958

	Total	Employed in the rubber industry		Not employed in the rubber industry	Not contacted
		Full time	Part time		
Malay	105	73	13	17	2
Chinese	25	15	5	5	0
Total	130	88	18	22	2
Percentage		67.7	13.8	16.9	1.5

Three outstation courses, at Pasir Puteh in Kelantan, Gemencheh in Negri Sembilan, and Kampong Paloh in Trengganu, were in progress at the end of the year with 76 students enrolled.

Rubber extension courses. Courses at a level of theoretical instruction higher than the Standard Course but still with emphasis on practical procedures applicable to smallholdings were provided for those with a better general education. These Rubber Extension Courses were held on one day each week over a period of six or seven months and certificates awarded to those successful in examinations.

Details of five courses of this type completed during the year are given in the Table.

RUBBER EXTENSION COURSES 1958

Location	Students enrolled	Students completing course		Awarded certificates	Examination. % pass
		Number	Percentage		
Batu Pahat (Chinese)	35	32	91.4	31	96.9
(Malay)	29	22	75.9	8	36.4
Bagan Bahru, Taiping (Malay)	30	18	60.0	5	27.8
Batu Tegoh, Taiping (Malay)	21	11	52.4	5	45.4
Machang, Kelantan (Malay)	32	25	78.1	15	60.0
Total	147	108	—	64	—
Percentage	100	73.5		43.5	

The marked variation in the results of these courses reflects the differences between the Rubber Instructors conducting them and particularly their experience with courses. This is unavoidable with courses provided at outstation centres where the demand must be met by the Instructor on the spot. The two courses at Taiping were seriously affected by the unavoidable transfer of the Rubber Instructor concerned; the courses had to be completed by a Junior Rubber Instructor.

It should be mentioned that the standard demanded on these Extension Courses was high and in view of this and the practical difficulties involved, the results are considered satisfactory. With more Rubber Instructors gaining experience in the organisation of courses and more detailed guidance from officers at headquarters future results are expected to be better.

Three Extension Courses at Batu Pahat (Malay and Chinese) and Kuala Pilah (Chinese) were in progress at the end of the year. The total number of students was 96.

Practical courses. Both standard courses and extension courses have been provided for some years but a new type of course was introduced during 1958. This was the 'practical course', first organised by Mr Lim Hong Hai for a group of smallholders at Labu in Negri Sembilan. The students, who were all smallholders, sons of smallholders, or tappers, attended sessions one day each week starting in July. The course will be completed early in 1959 when certificates of attendance will be awarded to those who complete it satisfactorily, although examinations will not be held.

A course similar to that at Labu was commenced at Kampong Krunei in Upper Perak in August and continued at the end of the year.

Most Rubber Instructors and Junior Rubber Instructors have provided practical demonstrations on subjects of topical interest from time to time; occasionally these have been arranged in series over a number of weeks so that they approximate to a 'practical course'. No certificates are given to those attending such series

of instructional demonstrations and the activities are not recorded separately. Nevertheless, this type of planned instruction is encouraged among Rubber Instructors and more particularly, Junior Rubber Instructors.

Courses at Rural Training Centres of the Department of Agriculture. Rubber Instructors or Junior Rubber Instructors have provided lectures on rubber during courses arranged by the Department of Agriculture at various Rural Training Centres. The amount of information provided on rubber at such courses varied from general interest lectures occupying one day to practical instruction over five or six days. Lectures or practical demonstrations were provided at the Rural Training Centres at Ajil, Cheras, Chembong, Ayer Hitam, Sungei Udang, Gajah Mati, Degong, Pekan and Kota Bahru.

Agricultural Shows

State or District Agricultural Shows provided an opportunity for Rubber Instructors to make contact with numbers of smallholders and others interested in the work of the Service. Instructional exhibits, on tapping, manuring, budgrafting or root disease were provided at twelve shows during the year, the shows being held in all States except Kedah. At all except one show, instructional films were used in connection with the exhibit provided.

At the State Agricultural Shows in Negri Sembilan and Kelantan and also at the Malayan Agri-Horticultural Society Show in Kuala Lumpur, sheet-making competitions were arranged. Latex, coagulant and equipment were provided and competitors were required to prepare three rubber sheets under the observation of judges. Prizes were awarded to winners and the competitions were popular with smallholders, 66 taking part in the three competitions. In future years it is hoped to organise competitions at all major agricultural shows in an attempt to bring the importance of producing good quality sheet to the attention of smallholders.

Mobile Film Unit

The film unit gave 138 shows in kampongs throughout the country and audiences continued to be large. In addition films were shown at all instructional courses. No film shows were given during the Muslim fasting month and the driver/projectionist worked at headquarters for this period.

Mobile Processing Demonstration

A demonstration unit was prepared by Mr Samuel to facilitate the work of Rubber Instructors and Junior Rubber Instructors in teaching the method for making good sheet rubber and to demonstrate the simple equipment necessary. This unit comprised complete processing equipment, collapsible racks for coagulating pans and a table for pressing sheet, together with a series of photographs illustrating the process. The equipment was carried in a Land Rover, thus facilitating visits to the smallest kampongs.

The unit was used to provide eleven demonstrations in West Coast States after an initial training tour during which its use was explained to Rubber Instructors and Junior Rubber Instructors. In addition to the practical demonstration of sheet making it was usually possible to show films on processing and, to complete the teaching, to provide leaflets for those interested at each centre.

Publications

The booklet 'Replanting on Smallholdings', originally published in 1955, was revised and an English edition printed. Revised Chinese and Malay (Jawi) versions were with the printer at the end of the year.

An illustrated leaflet 'Lalang Control with Dowpon' written by Mr Samuel, was published in English, Malay (Jawi) and Chinese. An edition in Romanised Malay was prepared at the request of the Sarawak Department of Agriculture and an Iban edition was also prepared for use in Sarawak.

For use in connection with the processing demonstration unit, Mr Samuel prepared a leaflet entitled 'Better Rubber and More Profit'. This was published in English, Jawi and Chinese and an Iban edition is to be prepared in Sarawak for use in that territory. In conjunction with the demonstration unit it is also proposed to employ posters emphasising the important points in the preparation of good quality sheet. A series of six posters was planned using the general slogan 'Getah dibaikkan rezeki dinaikkan' and the art work was commissioned during December.

Revised Jawi and English editions of a poster illustrating the technique of bud-grafting were received from the printer.

Rubber Industry (Replanting) Board Publicity Campaign

A specially organised publicity campaign was conducted by the Rubber Industry (Replanting) Board during the two months of October and November to bring the importance of replanting to the notice of smallholders and to encourage applications for replanting grants for the 1959 season. A mobile exhibit was used, ten units touring all parts of Malaya and spending one day at each centre visited.

Assistance was provided by Smallholders' Advisory Service officers who served on the Central and State Planning Committees. A Rubber Instructor or Junior Rubber Instructor attended each exhibition to answer technical questions and in some cases to provide a talk on the technique of replanting. The R.R.I. film on replanting was also used at the exhibitions.

INVESTIGATIONS

Trials with 'Mac & Lai Additive'

Mac and Lai Additive, used with a normal coagulant for sheet production, was claimed to hasten the drying of sheet, to prevent mould growth and to give a colour similar to smoked sheet. After investigations by the Chemical Division the additive was tried under smallholding conditions, small samples being provided to Rubber Instructors.

Results indicated that sheet was coloured like smoked sheet and was resistant to mould but that the drying time was not decreased either in the smokehouse or at air temperature.

The additive may be of limited interest to smallholders in that it will enable them to air-dry their sheet completely before sale without fear of mould growth, but the benefit is likely to be small as dealers must still smoke the sheet before it can be exported as a standard grade.

Lalang Spraying Demonstration Trials

Trials of 'Dowpon' as a lalang killer were completed and our field staff co-operated with staff of the Rubber Industry (Replanting) Board in demonstrations on smallholdings. These were invariably successful where 'Dowpon' was used at the rate of 20 lb per acre on sheet lalang and the weedkiller is now being distributed to smallholders undertaking replanting with the Replanting Scheme.

Clone Demonstration Plots

Distribution has been continued of small quantities of budwood of RRIM 600 Series clones to selected smallholders who will establish observation plots for comparison with the older proved clones. Eight plots were established using 181 yards budwood of clones RRIM 605, 607, 612 and 623.

Survey of Replantings Receiving the Final Replanting Grant

The field work for a survey of conditions on smallholdings for which the final Replanting Grant has been paid was completed. The returns have been analysed for the preparation of a separate report. The survey covered 1,097 smallholdings totalling 5,274 acres of replanting, of this area 47.6% was budgrafted and the remainder planted with clonal seedling material. The growth of both types of rubber failed to reach the standard expected on an average estate but it appeared to be little affected by stands per acre or species of cover. It was apparent that budgrafting required closer control as only 67% of the budgrafted holdings could be considered satisfactorily budded, judged on the final stand per acre of well grown trees.

J. M. F. Greenwood
Acting Smallholders' Advisory Officer

Estates Advisory Service

It is the Board's intention to implement the recommendations contained in the report of the Blackman Committee, paragraphs 45 to 47, on the subject of advisory services for estates. Staffing presents a major problem in the new service since it is considered undesirable that it should be established at the expense of the research work of the Institute.

In establishing an Estates Advisory Service it is proposed in the first instance to observe the fairly distinct separation, which we note in our research, between work on production, up to the time the latex leaves the rubber tree, and work on the product, the field of the Chemical Division. The aim of the new service is to undertake all routine advisory work required in the fields of the Soils, Botanical and Pathological Divisions. The advisory work of the Chemical Division has for several years been the charge of a single specialist officer and it will be for consideration at a later date whether closer union of advisory work for field and factory is desirable.

Mr L. R. Davidson returned from long leave on 3 October to take charge of the development of the new service. During October and November Mr Davidson was able to study current work of the Rubber Research Institute in the advisory field and to make plans and arrangements for undertaking this work in the future. Attention has also been given to requirements for extending the influence of the Institute amongst rubber growers. It is considered that there is a special need for an intensive effort on behalf of the smaller estates of about 1,000 acres or less. This objective will be kept in view as further appointments are made in the new service.

From December Mr Davidson assumed responsibility for advisory work in the field of the Soils Division although work undertaken during this month has been incorporated in the summary of the advisory work of the Soils Division. The intention is for the Estates Advisory Service to assume responsibility in succession for the advisory work of the Botanical and Pathological Divisions. Difficulty in securing fully experienced officers to undertake general advisory duties will limit the speed with which this process of transfer can be carried out.

L. R. Davidson
Head of Estates Advisory Service

Statistical Section

The post of Head of the Statistical Section remained unfilled. Mr A. Fong Chu Chai, Acting Statistician, was on duty throughout the year.

The Statistics Section continued to be fully employed in analysing Divisional experimental data and in providing advice on the design of new experiments. During the year, 133 reports on statistical analyses of experimental data were submitted to the Divisions.

Five visits to the Experiment Station and four visits to estates were made in connection with the planning of new experiments.

Girth data from field experiments continued to be recorded on cards, and summarised by means of the Power Samas machinery. In addition, the data from five field surveys were analysed with the aid of this equipment.

Publications and Information Section

Planters' Bulletin continues to play an important part in the dissemination of technical advice to planters. Numbers 34–39 were published at two-monthly intervals during the year. An advisory booklet and several advisory leaflets were issued. The *Journal of the Rubber Research Institute* Volume 15, Part IV (Communications 315–21) was published. Part V (Communications 322–3) was sent to the press. An illustrated book 'Maladies of Hevea in Malaya' was finally completed and made ready for printing by the Pathological Division.

As the post of Publications Officer remained unfilled, Dr Newsam, Head of Pathological Division, continued to take charge of the Publications Section in addition to his own duties.

R.R.I. Experiment Station

The manager returned from home leave in May. Mr A. E. Browne, deputy manager was on home leave from June to November. Mr J. D. Macritchie, assistant manager went on home leave in December. Mr J. H. Chapman, the other assistant manager, was on duty throughout the year.

Six members of the junior staff took long leave during the year.

Training courses. A training course was held for prospective Junior Rubber Instructors from September to December.

Two courses of a month's duration were held for kampong youths. The first was attended by thirty-nine Malays and the second by sixteen Chinese.

Visitors. There were five hundred and seventy-six visitors to the Station during the year.

Emergency. Sungei Buloh area including the Experiment Station was declared a White Area in May. There were no incidents of terrorist activity and all emergency restrictions have been removed.

Health. The health of labour force and staff resident on the station has been good generally throughout the year. There were thirty-five births and four deaths. Sixty-eight cases were admitted to hospital and nine hundred and sixteen cases were treated locally.

Acreage. Details of the acreage statement at 31 December were:

			Acres
Mature area:	in tapping		1,143.75
Immature area:	new planting	962.00 acres	
	replanting	234.75 ,,	1,196.75
Nurseries			43.75
Seed Gardens:	mature, in tapping	154.50 acres	
	immature	47.75 ,,	202.25
Total planted acreage			2,586.50
New clearing in preparation			214.50
Building site and roads			89.25
Reserve land, swamp etc.			88.75
			2,979.00

Rainfall. The total rainfall in 1958 was 85.98 inches. Rain fell on 172 days.

NEW PLANTING AND REPLANTING

New Planting

Two hundred and fourteen and a half acres of jungle were felled in December for clearing and planting in 1959.

No new planting was done during the year.

Replanting

Field 17 (34½ acres) was felled for replanting. Two methods of clearing were compared:

(a) Mechanical uprooting of the old trees followed by rooting and harrowing.

(b) Felling the old trees at the collar and poisoning of the stumps.

The whole field has been devoted to cover crop experiments. The various cover species were established by the end of the year but further supplying will be necessary in some cases. The area was planted with germinated seed for budding in 1959, except for 4¾ acres which were left unplanted and are reserved for planting with material which may be obtained from the vegetative propagation work now in progress.

Five acres of old rubber at the north end of Field 15 were felled, clean-cleared mechanically and planted at 2 ft × 2 ft with germinated seed to give an additional multiplication nursery.

IMMATURE AREAS

Budgrafting

The following fields were budgrafted during the year:

Field 61C: 43 acres, small scale trial of four hundred and ninety-eight new clones made from the 1956 hand pollinated crosses.

Field 61D/E: 18 acres. Clones RRIM 501, 513, 613 and 623 were budded in these areas.

Field 60F: 24 acres. Crown budding experiment. *Dothidella*-resistant clones were used for budding in the plots intended for crown budding. Cutting back is due early in 1959.

Field 23: (a) 29 acres. Cover crop experiment. This area was budded as a monoclone block with clone RRIM 603.

(b) 32½ acres. Seed garden. Clones RRIM 612, 622 and 501 were budded in successive rows.

Field 63C: 40 acres. Clonal manuring experiment. Clones LCB 1320, GT 1 and PB 86 were budded in this trial at the end of the year. Cutting back will be done early in 1959.

Manuring

Fertilisers were applied over 861½ acres of immature rubber, as detailed below:

Field	*Acres*	*Rate per tree*	*Fertiliser*	
6 and 6A	44	4 + 6 + 8 oz	Magnesium Mixture	X
23	61	4 oz	,, ,,	X
24	32	4 + 6 + 8 oz	,, ,,	M
16N	10¾	2 lb	,, ,,	Y
17	34½	4 oz	Rock phosphate	
		4 oz	Magnesium Mixture	X
52	60	2 lb	Mixture D	
53	48¾	1½ lb	,, B	
54 (discard)	34	2 lb	Special Mixture	

Field	*Acres*	*Rate per tree*	*Fertiliser*
55	49¼	2 lb	Mixture D
56	51¾	2 lb	,, D
57	40	2 lb	,, D
58	74	1½ lb	,, D
60A.C.F.G.	73½	1 lb	,, D
60B.D.	134	1 lb	,, M
60H	48	½ lb	,, D
62	66	6 oz	,, M

Two hundred and eighty-seven and a half acres of leguminous covers were manured in the following areas:

Field	*Acres*	*Fertiliser application per acre*
6 and 6A	44	Covers received 1 cwt Magnesium Mixture Y + ¾ cwt rock phosphate
23, cover expt	29	All treatments received 1 cwt rock phosphate
23, discard	32½	Covers received 1 cwt basic slag
24, cover expt and discard	32	Covers received 1 cwt rock phosphate
61	84	Covers received 1 cwt rock phosphate
62	66	Covers received 1½ cwt rock phosphate

Thinning Out

Field 47. D plots were thinned to 140 trees per acre.

Field 51B. (Crown budding experiment). The stand was reduced to 120 trees per acre.

Fields 52 and 56A. (Small scale clone trial). The stand was reduced to 9 trees per plot or 135 trees per acre.

Supplying

Cover crop experiments in Field 23 and 24 were supplied with budded stumps of the appropriate clones.

Pests and Diseases

Root disease. One thousand four and three quarter acres of immature rubber were under control for root disease by the collar inspection method. Incidence of disease in new plantings and replanting is given below.

	New planting		*Replanting*		*Total*
Area collar inspected	864¼ acres		140½ acres		*no.*
Cases	*Treated*	*Removed*	*Treated*	*Removed*	*cases*
Fomes lignosus	407	349	41	104	901
Ganoderma	34	49	11	5	99
Fomes noxius	21	41	2	5	69
Poria	6	—	—	—	6
Ustulina zonata	14	6	1	1	22
	482	445	55	115	1097

Pink disease. Four hundred and twenty-three and a quarter acres of young rubber were under regular inspection. A total of 8,724 cases were treated.

Termites. All young rubber in Fields 23, 24, 58, 60 and 61 (541½ acres) received prophylactic treatment for termites with Aldrex 2.

Storm damage. 448 cases pruned; 56 fallen trees cleared.

General Maintenance of Immature Areas

Regular weeding rounds were maintained. In the 1956 and 1957 clearings selective weeding of inter-rows and clean weeding of planting rows were practised. Periodic strip spraying of planting rows was carried out in fields where rubber was over five years old.

Natural covers were kept slashed to 3 feet and drains were cleaned quarterly.

MATURE AREA

The system of maintenance and upkeep of mature rubber areas remained unchanged.

Manuring

Only two fields of mature rubber received fertilisers:

Field 38 (60 acres) received 4 lb per tree of Mixture E
,, 49 (55 ,,) ,, 4 lb ,, ,, ,, ,, B

Pests and Disease

Root disease. Collar inspection and treatment was carried out around known disease areas over 184 acres of young mature rubber.

Area inspected	184 acres
Cases treated	8 ,,
Cases eradicated	7 ,,

Pink disease. Two hundred and two acres were patrolled regularly for pink disease. A total of 550 cases were treated, most of which were clone RRIM 501.

Termites.	Cases treated — 1,252
	Dead trees removed — 71
Storm damage.	Cases pruned — 1,333
	Fallen trees cleared — 922

Tapping

The area in tapping at the end of the year was 1,298¼ acres. During the year the following fields were brought into tapping:

Location	*Acres*	
Field 52C	9.75	Hand pollinated seedling trial and a demonstration plot of clone RRIM 520.
Field 51E	5.00	Clone PR 107
Seed garden D	13.00	
Total	27.75	

Thirty-nine and a half acres of old rubber were felled for replanting.

Fields 14A/B and 19 were under 2 s/2, 200% intensive tapping during the year.

Yield stimulants (non-experimental) were applied in the following fields.

Field 15, (10 acres, due for replanting) on high cut s/2,d/2,200%

,, 19, on high cut s/2, d/2, 200%

,, 4A, on high cut s/1, d/2, 100%

,, 5A, and 25(i) on 'island' bark.

Crop and Manufacture

The total crop for the year was 1,249,393 lb which gives an average yield per acre of 962 lb.

The following grades of rubber were manufactured:

RSS	422,172 lb
Latex concentrate ...	168,649 ,,
SP sheet	256,408 ,,
SP brown crepe ...	31,500 ,,
SP pale crepe	608 ,,
SP (masterbatch) ...	2,885 ,,
Scrap crepes	224,143 ,,
Skim crepes	19,576 ,,

The following crop was sold unmanufactured:

Scrap	15,985 ,,
Cup samples	103,436 ,,
Latex	4,031 ,,
	1,249,393

Seed Gardens and Multiplication Nurseries

All ground covers in the Smallholders' Seed Gardens were sprayed with sodium arsenite and the gardens (192 acres) were kept clean for seed collection from July to December.

Manurial experiments have been laid down over part of the seed gardens. Gardens A, C, D2 and D3, where no manurial experiments exist, received an application of 4 lb per tree of Magnesium Mixture Y.

Three rounds of pink disease inspection were carried out and 356 cases were treated.

The seed fall was poor. A total of 244,800 seeds was harvested and distributed to nurseries for smallholders.

Only a small area of budwood nurseries remained interplanted between the avenues of the seed gardens. The remaining budwood is likely to be used or eradicated early in 1959.

Of the 43¾ acres listed as multiplication nurseries in the acreage statement, 5 acres were newly planted during the year, 5 acres were ready for budding at the end of the year and 3 acres are very old nursery which will be eradicated in 1959.

Budwood despatches during the year were:

To smallholders from smallholders' nursery	1,240 yards
To estates and smallholders from Experiment Station nurseries	9,041 ,,

EXPERIMENTAL

Further details of work under this heading are contained in the reports of the Divisions concerned.

Recording

Yield recording in experimental areas continued to be done by the cup coagulation method.

Girth, height and bark measurements were recorded in most experimental areas.

Manurial Trials

Five major manurial trials in Fields 31, 47, 54, 63B and 63C received fertiliser applications in accordance with schedules.

The manurial-cum-cultivation trial in Field 15 and manuring-cum-planting technique trial in Field 60E also continued to receive fertiliser applications and cultivation treatments according to programme.

Spraying Trials

A number of small scale spraying trials were carried out with various herbicides and weedicide sprays on grasses, *Mikania*, rubber seedlings and ferns.

Cover Crop Trials

Cover trials in Fields 6, 23, 24 and 60A were maintained throughout the year and one new trial of various covers was started in Field 17.

Tapping and Yield Stimulant Experiments

Tapping experiments in Fields 5, 16(S), 21, 22 were continued. Yield stimulant trials were carried out in a number of fields. Fields 5 (boundary) 10, 14C/D (boundary) 14E, 15 (part), 16, 18, 20B, 25 (4 and 5) and 33 (part) were under stimulant trials for various periods during the year or the whole year.

Clone Trials

At the end of the year 472 acres were under small scale clone trials and 310 acres under large scale clone trials.

Hand Pollination

7,088 pollinations were made between selected clones—121 fruits were harvested.

BUILDING AND MAINTENANCE

Buildings

Two new units of semi-detached junior staff quarters were erected.

Septic tank sanitation was installed in twenty-four staff quarters and ten artisan's quarters to replace bucket latrines.

Eight junior staff quarters and the office were painted and maintenance repairs were carried out.

Maintenance repairs were carried out throughout the labour lines and the weatherboarding of all lines was creosoted.

A community hall was built on the west side of the labour lines.

New cattle sheds were erected on the east boundary of the cattle area.

An incinerator was built on the south boundary of Field 18.

A chlorination and filtration plant was added to the water supply.

A petrol pump and diesel pump were erected near the office garages.

The workshop buildings were extended.

The crepe drying tunnel was extended to give double the drying capacity.

Roads

One hundred and thirty chains of roadway on the main building site were metalled and tarred.

LABOUR

There was an ample supply of labour. The labour strength on 31 December was:

On check roll	*Men*	*Women*	*Children*	*Total*
Indians	212	191	31	434
Malays	15	—	—	15
Total on check roll ...	227	191	31	449
On contract				
Malays	23	6	—	29
Chinese	—	4	—	4
Total workers	250	201	31	482
Dependants (Indians)	5	16	363	384

R. F. Harley
Manager
R.R.I. Experiment Station

SENIOR STAFF*

ADMINISTRATION

C. E. T. Mann, M.Sc., F.I.R.I., *Director.* (15 June 1927)
C. G. Akhurst, B.Sc., A.R.C.S., A.I.C.T.A., *Deputy Director.* (7 October 1930)
H. S. Blacklin, *Secretary.* (1 March 1932)
J. C. Reeves, F.C.C.S., *Assistant Secretary.* (11 September 1950)
J. A. Faulkner, *Maintenance Engineer.* (1 November 1955)

PUBLICATIONS SECTION

Vacant. *Publications and Information Officer*

STATISTICS SECTION

Vacant. *Statistician*
A. Fong Chu Chai, B.Sc., Dip. Arts, *Assistant Statistician.* (8 July 1949)
G. Chidambara Iyer, M.Sc., *Assistant Statistician.* (20 August 1955)

EXPERIMENT STATION

R. F. Harley, M.C., F.I.S.P., *Manager.* (27 August 1937)
A. E. Browne, M.C., *Deputy Manager.* (1 February 1948)
J. D. Macritchie, B.Sc. (Agri.), *Assistant Manager.* (15 December 1954)
J. H. Chapman, B.Sc. (Agri.), *Assistant Manager.* (19 August 1955)

SOILS DIVISION

G. Owen, M.Sc., F.I.S.P., *Head of Division.* (5 January 1939)
G. A. Watson, M.Sc., Ph.D., A.R.C.S., D.I.C., A.R.I.C., *Soils Chemist.* (17 November 1955)
V. M. Shorrocks, M.A., D.Phil., M.I. Biol., *Plant Physiologist.* (28 August 1957)
K. L. Middleton, M.Sc., A.R.I.C., *Soils Chemist.* (16 October 1958)
J. Bolton, B.Sc., A.R.I.C., *Agronomist.* (25 October 1958)
M. M. Guha, B.Sc., Assoc. I.A.R.I., *Assistant Soils Chemist.* (20 May 1955)
K. Raman, M.Sc., *Assistant Soils Chemist.* (23 April 1958)

BOTANICAL DIVISION

C. W. Brookson, B.Sc., *Head of Division.* (23 August 1949)
P. de Jonge, l.i., *Botanist.* (29 December 1950)
P. R. Wycherley, Ph.D., *Botanist.* (26 January 1953)
J. M. Ross, B.Sc., *Botanist.* (5 December 1955)
S. G. Boatman, Ph.D., *Botanist.* (2 November 1956)
J. K. Templeton, M. Agr. Sc., D. Phil., *Botanist.* (24 January 1958)
E. C. Paardekooper, l.i., *Botanist.* (23 June 1958)
G. H. Tinley, M.Sc., *Botanist.* (26 November 1958)
T. V. Vaidyanathan, B. Agric., *Assistant Botanist.* (1 May 1935)
M. M. Chandapilla, B.Sc., *Assistant Botanist.* (2 January 1958)
P. D. Abraham, B.Sc., *Assistant Botanist.* (13 October 1958)

* The date of first appointment of members of the staff is given in brackets after each name.

PATHOLOGICAL DIVISION

A. Newsam, Ph.D., *Head of Division.* (5 April 1947)
F. W. Hutchison, N.D.A., C.D.A., *Field Research Officer.* (5 March 1948)
R. N. Hilton, M.A., *Pathologist.* (7 September 1948)
R. A. Fox, B.Sc., B. Agr., *Microbiologist.* (2 March 1954)
K. P. John, B.A., *Assistant Pathologist.* (16 November 1936)
B. S. Rao, M.A., *Assistant Entomologist.* (6 June 1952)

CHEMICAL DIVISION

W. G. Wren, B.Sc., A.R.C.S., D.I.C., A.I.R.I., *Head of Division.* (7 January 1950)
G. W. Drake, B.Sc., M.A., *Chemist.* (8 March 1948)
W. A. Southorn, Ph.D., A.R.I.C., *Chemist.* (18 November 1952)
J. E. Morris, B.Sc., *Chemist.* (20 June 1952)
R. S. Gale, B.Sc., A.C.G.I., A.M.I. Chem. E., *Chemical Engineer.* (2 May 1951)
D. J. Graham, A.S.T.C., A.R.A.C.I., *Chemical Engineer.* (31 March 1953)
D. H. Taysum, M.Sc., D.I.C., *Microbiologist.* (13 September 1954)
G. F. J. Moir, B.Sc., *Biochemist.* (2 February 1955)
B. C. Sekhar, B.Sc., M.S., A.R.I.C., A.I.R.I., *Chemist.* (15 September 1949)
C. A. K. Salgado, B.Sc., *Technologist.* (22 April 1957)
F. W. Shipley, Ph.D., *Chemist.* (6 August 1958) Seconded from B.R.P.R.A.
T. V. Molesworth, B.Sc., (Tech), A.M.I. Chem. E., *Chemical Engineer.* (22 April 1957)
P. S. Nielsen, A.N.C.R.T., *Technologist.* (1 October 1958)
K. C. Sekar, B.A., A.I.R.I., *Assistant Chemist.* (1 October 1928) Retired 24 March 1958.
R. C. H. Hsia, B.Sc., *Assistant Chemist.* On study course in England. (2 January 1953)
S. J. Tata, B.Sc., *Assistant Chemist.* (14 December 1953)
ST. Sethu, B.E. (Chem.), *Assistant Chemical Engineer.* On study course in England. (1 September 1955)
A. Karunakaran, B.Sc., *Assistant Biochemist.* (25 November 1957)
N. M. Pillai, B.A., F.I.C.S., *Assistant Chemist.* (29 October 1958)

SMALLHOLDERS' ADVISORY SERVICE

L. R. Davidson, B.Sc. (Agric.), *Smallholders' Advisory Officer.* (1 December 1940). Transferred to Estates Advisory Service 3 October 1958.
J. M. F. Greenwood, B.Sc. (Agric.), *Assistant Smallholders' Advisory Officer.* (25 November 1948)
Shamsuddin bin Yub Ahmad, B. Agr., *Assistant Smallholders' Advisory Officer.* Seconded to Federal Land Development Authority from 1 April. (1 May 1938)
J. G. Samuel, B.Sc. (Agric.), *Assistant Smallholders' Advisory Officer.* (1 May 1939)
Mohd Johar bin Mohd Rashid. *Assistant Smallholders' Advisory Officer.* (1 August 1958)

LIABILITIES

			31.12.58	As at 31.12.5
SUNDRY CREDITORS	$ c.	$ c.	$ c.	$
Staff	60,601.78			
Merchants	380,466.70			
Miscellaneous	3,297.77		444,366.25	292,8
STAFF CONTINGENCY RESERVE FUND				
As at 31 December 1957			330,000.00	330,0
RESERVE FOR GRATUITIES FOR EQUALISATION OF PROVIDENT FUND CONTRIBUTIONS	50,119.60			48,8
Less Investments of these Funds in the Post Office Savings Bank	50,119.60		—	48,8
EXCESS OF ASSETS OVER LIABILITIES				
As at 31 December 1957	4,307,846.78			
Less Buildings written off	364,980.02			
	3,942,866.76			
Add Excess of Income over Expenditure for the year:				
Head Office		$ 1,524,788.19		
Experiment Station		87.046.61		
	1,611,834.80		5,554,701.56	4,307,4
Carried forward			6,329,067.81	4,930,6

ASSETS			31.12.58	As at 31.12.57
D & BUILDINGS		$ c.	$ c.	$
2¼ Mile compound				
Land as at 31 December 1957		15,784.35		
198 and 200 Ampang Road:				
At nominal value		2.00	15,786.35	15,786
3rd Mile Compound				
Land as at 31 December 1957		31,440.35		
251, 253, 255, 257, 259 and 261 Ampang Road: ...				
At nominal value		6.00	31,446.35	31,446
3¼ Mile Compound				
Land as at 31 December 1957		27,582.50		
262, 264, 266, 268 and 270 Ampang Road:				
At nominal value		5.00	27,587.50	27,588
4th Mile Compound				
Land as at 31 December 1957		2,000.00		
73, 4th Mile Ampang Road:				
At nominal value		1.00	2,001.00	2,001
Eaton Road Compound				
Land as at 31 December 1957		17,147.08		
1, 3, 5 and 7 Eaton Road:				
At nominal value		4.00	17,151.08	17,151
Wickham Road & Ridley Close				
Land as at 31 December 1957		43,623.50		
9 Bungalows — at nominal value		9.00	43,632.50	43,633
Ulu Klang Heights				
Flats			1,515.00	—
Ulu Klang				
Land as at 31 December 1957		7,705.00		
Workmen's Quarters — at nominal value		1.00	7,706.00	7,706
Ampang Road Laboratories				
Land as at 31 December 1957		19,526.00		
Buildings as at 31 December 1957		75,333.15		
		94,859.15		
Additions during the year		11,553.81		
		106,412.96		
Less Buildings written off		78,187.28	28,225.68	94,859
Sungei Buloh Laboratories & Houses				
As at 31 December 1957 —				
At nominal Value:				
Laboratories		1.00		
Houses		24.00	25.00	25
Carried forward			175,076.46	240,195

	31.12.58	As at 31.12.57
	$ c.	$
Brought forward	6,329,067.81	4,930,6
Carried forward	6,329,067.81	4,930,6

				31.12.58	As at 31.12.57
				$ c.	$
			Brought forward	175,076.46	240,195
Land & Quarters for Rubber Instructors					
Land			9,627.50		
Buildings at nominal value			10.00	9,637.50	
Land & Quarters for Rubber Instructors (under construction)					
As at 31 December 1957			248,998.34		
Additions during the year			78,277.21		
			327,275.55		
Less Quarters completed					
Land		9,627.50			
Building at nominal value		10.00			
		9,637.50			
Furniture at nominal value		10.00			
		9,647.50			
Buildings written off		244,295.87	253,943.37	73,332.18	248,998
Pilot Instruction Centre					
As at 31 December 1957					
Land		6,597.00			
Buildings		42,497.87	49,094.87		
Additions during the year					
Land			1,700.94		
			50,795.81		
Less Buildings written off			42,496.87	8,298.94	49,095
NT AND MACHINERY					
As at 31 December 1957			1.00		
Additions during the year			121,579.23	121,580.23	1
NITURE					
Residential Houses, Kuala Lumpur					
At nominal value			1.00		1
Quarters for Rubber Instructors					
At nominal value			10.00		—
Sungei Buloh					
At nominal value			1.00		1
Offices, Kuala Lumpur					
At nominal value			1.00		1
Library					
At nominal value			1.00		1
Laboratories					
At nominal value					
Kuala Lumpur		1.00			
Sungei Buloh		1.00	2.00		2
			16.00		6
PARATUS AND GLASSWARE					
At nominal value			1.00		1
			Carried forward	387,942.31	538,296

	31.12.58	Aa st 31.12.5
	$ c.	$
Brought forward	6,329,067.81	4,930,6
Carried forward	6,329,067.81	4,930,6

			31.12.58.	As at 31.12.57.
			$ c.	$
OR VEHICLES				
At nominal value	Brought forward	387,942.31		538,296
		1.00		1
KSHOP				
At nominal value		1.00		1
ARY BOOKS AND PERIODICALS				
At nominal value		1.00		1
RIMENT STATION DEVELOPMENT				
As at 31 December 1957		2,608,946.10		
Additions during the year		417,260.79		
		3,026,206.89		
Less Government Rubber Replanting Scheme Grants		117,427.00	2,908,779.89	2,608,946
KS				
Petrol, Oil & Chemicals				
Head Office	214.42			201
Experiment Station	2,987.82	3,202.24		1,968
Empty Containers & Drums				
Head Office	165.50			221
Experiment Station	200.00	365.50		2,092
Stationery				
Head Office		11,207.42		9,563
Sundry Materials				
Head Office	14,833.76			15,446
Experiment Station	20,708.68	35,542.44		22,900
Rubber				
Experiment Station		50,909.74	101,227.34	41,012
				93,403
DRY DEPOSITS			295.00	280
DRY DEBTORS				
Staff				
Loans for Motor Vehicle Purchase		262,025.93		218,234
Travelling and Sundries		31,688.69		21,327
		293,714.62		
General				
Head Office	106,772.37			166,563
Experiment Station	8,021.79	114,794.16		2,084
Interest accrued on Investments		3,806.41		7,136
Payment in Advance				
Head Office	28,603.99			25,825
Experiment Station	7,836.48	36,440.47	448,755.66	4,723
				445,892
	Carried forward		3,847,003.20	3,686,820

	31.12.58	As at 31.12.1
	$ c.	$
Brought forward	6,329,067.81	4,930,

REPORT OF THE AUDITORS TO THE BOARD OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

We have examined the above Balance Sheet with the books and vouchers of the Institute and have obtained all the information and explanations we have required.

Titles to certain of the Institute's lands have not yet been issued.

Subject to the foregoing, in our opinion, the said Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Institute's affairs at 31 December 1958 according to the best of our information and the explanations given to us and as shown by the books of the Institute.

Kuala Lumpur
24 March 1959

Sgd Peat, Marwick, Mitchell & Co.
Chartered Accountants
Auditors

	$6,329,067.81	$4,930,

		31.12.58	As at 31.12.57
		$ c.	$
	Brought forward	3,847,003.20	3,686,820
L AND BRITISH GOVERNMENT SECURITIES			445,892
(Held for account of Staff Contingency Reserve Fund)			
$ 15,000/- 4½% Singapore Municipal Debenture Stock 1930–70/80 ($17,537 †) ($11,924 *)	15,000.00		15,000
$ 40,000/- 3% F.M.S. Government War Loan 1940–52/59 ($40,000 †) ($38,700 *)	40,000.00		40,000
$160,000/- 3% Malayan Union Government Loan 1946–62/66 ($160,000 †) ($128,996 *)	160,000.00		160,000
£ 20,600/- 3½% British War Loan 1952 ($145,322 †) ($115,366 *)	145,322.05		145,322
		360,322.05	360,322
† Original Cost — $362,859			
* Market Value as at 31 December 1958 — $294,986			
AT BANK AND IN HAND			
At Bank			
Fixed Deposit	1,200,000.00		
Current Account	913,294.90		
	2,113,294.90		
In Hand	8,447.66	2,121,742.56	883,529
		6,329,067.81	4,930,671

Income & Expenditure Account (excluding Experime

EXPENDITURE

To	31.12.58	Year to 31.12.57
	$ c.	$
London Advisory Committee	28,494.49	20,629
Board Meetings	3,362.80	2,868
Salaries of Staff on Agreement	827,683.45	574,114
Salaries of Staff not on Agreement	1,408,557.36	1,107,195
Provident Fund	217,596.94	189,867
Medical	34,932.12	30,807
Travelling	94,960.28	79,499
Office General Charges	55,728.91	44,625
Rents, Rates and Taxes	19,902.12	15,247
Insurance	27,207.23	24,231
Laboratory General Charges	9,159.62	7,454
Buildings and Grounds	182,262.01	98,907
Furniture and Office Equipment	45,699.90	30,132
Fixtures and Fittings	46,499.49	47,201
Plant and Machinery	108,618.62	150,919
Vehicles Maintenance	21,320.22	20,530
Workshop	14,816.04	17,535
Apparatus and Glassware	161,365.89	122,964
Laboratory Chemicals	30,908.81	38,628
Publications	83,988.54	23,371
Library (Books and Periodicals)	19,258.04	20,732
Exhibitions	2,450.22	5,142
Smallholders Advisory Service	644,379.03	545,754
Field and Factory Experiments	115,381.64	122,775
Technical Classification	23,855.56	34,103
Gratuities to Staff	319,032.24	22,492
Leave Pay	102,142.99	192,758
Passages	102,631.84	110,285
Grant towards Passages	1,508.00	1,394
Scholarship	6,667.50	1,529
	4,760,371.90	3,703,687
Excess of Income over Expenditure for the year	1,524,788.19	396,387
	6,285,160.09	4,100,074

Income & Expenditure Account for Experime

EXPENDITURE

To	$ c.	$
Revenue Expenditure	793,887.88	784,706
Excess of Income over Expenditure for the year	87,046.61	180,357
	880,934.49	965,063

ıtion) for the year ended 31 December 1958

INCOME

By	31.12.58	Year to 31.12.57
	$ c.	$
Contribution received from The Malayan Rubber Fund	6,193,980.00	4,000,000
Publications Sold	16,032.43	13,767
Rents on Houses	17,402.06	22,556
Interest on Loans	4,071.69	3,355
Interest on Investments	23,136.03	30,008
Miscellaneous	30,537.88	30,388
	6,285,160.09	4,100,074

ation for the year ended 31 December 1958

INCOME

By	$ c.	$
Sales and Stock of Rubber	821,003.64	857,776
Sales of Replanting Materials	24,205.19	58,544
Miscellaneous	270.00	—
Rubber Industry (Replanting) Board		
Refund on account of Replanting Cesses	20,362.41	26,994
Refund on account of Anti-inflationary Cesses	15,093.25	21,749
	880,934.49	965,063

No. 71 OF 1958

THE MALAYAN RUBBER FUND (RESEARCH AND DEVELOPMENT) ORDINANCE, 1958

An Ordinance to provide for the levy of a cess on rubber grown in the Federation and for the establishment and administration of a fund for the purpose of financing research, development and publicity for increasing or stimulating the production and consumption of natural rubber and other purposes relating thereto.

[ ]

IT IS HEREBY ENACTED by the Yang di-Pertuan Agong with the advice and consent of the Legislative Council as follows :

Short title and commencement.

1. This Ordinance may be cited as the Malayan Rubber Fund (Research and Development) Ordinance, 1958, and shall come into force on such date as the Minister may by notification in the *Gazette* appoint; and the Minister may appoint different dates for the coming into force of different provisions of this Ordinance.

Interpretation.

2. In this Ordinance, unless the context otherwise requires—

"Board" means the Board established by section 3;

"Controller" means the Controller of Rubber Research appointed under Part II, and includes the Deputy Controller (if any);

"cess" means the cess imposed or deemed to be imposed under section 14;

"Deputy Controller" means the Deputy Controller of Rubber Research (if any) appointed under Part II;

"Fund" means the Malayan Rubber Fund established under section 13;

"Minister" means the Minister for the time being charged with responsibility for the rubber industry; *F.M.S. Cap. 108.*

"Rubber Research Institute" means the Rubber Research Institute of Malaya constituted by the Rubber Research Institute Enactment of the Federated Malay States;

"Rubber Producers' Council" means the Rubber Producers' Council of the Federation of Malaya;

"Selection Committee" means a Selection Committee appointed under section 10.

Part I

MALAYAN RUBBER FUND BOARD

Establishment of Board.

3. (1) For the purposes of this Ordinance there is hereby established a Board, which shall be a body corporate by the name of the "Malayan Rubber Fund Board".

(2) The Board shall have perpetual succession and a common seal, and may acquire and hold property, movable and immovable, and transfer or otherwise deal therewith, sue and be sued in its own name, enter into contracts and do all things necessary for or incidental to its functions under this Ordinance.

(3) The seal of the Board shall be affixed in the presence of the Controller and one other member of the Board who shall sign every deed or other document or instrument to which such seal is affixed and such signing shall be sufficient evidence that such seal was duly and properly affixed and that the same is the lawful seal of the Board.

(4) The Board shall consist of ten members, as follows:

(*a*) the Controller, who shall be chairman;

(*b*) five members appointed by the Rubber Producers' Council;

(*c*) two members appointed by the Minister after consultation with the Rubber Producers' Council;

(*d*) two members appointed by the Minister.

(5) The appointers specified in paragraphs (*b*), (*c*) and (*d*) of sub-section (4) may appoint one or more persons to be alternate members of the Board, anyone of whom may attend meetings of the Board when a substantive member is temporarily unable to attend; and when so attending such alternate member shall be deemed for all purposes to be a member of the Board.

(6) The members of the Board appointed under this section shall hold office for three years from the date of their appointment, and shall be eligible for re-appointment.

Procedure of the Board.

4. (1) At any meeting of the Board six members shall form a quorum.

(2) A decision of the majority of the members of the Board present and voting at a meeting of the Board shall be deemed to be a decision of the Board.

(3) The Chairman shall vote as a member but in the event of an equality of votes he shall not have any casting vote and shall in such event refer the issue to the Minister, whose decision thereon shall be final.

(4) In the absence from any cause of the Chairman from any meeting, the members of the Board present shall elect an acting chairman for that meeting.

(5) The Board shall hold at least four ordinary meetings in each year.

(6) A special meeting of the Board may be called at any time by the Controller, and shall be called at the request of any four members.

(7) Subject to the provisions of this section the Board may regulate its own procedure.

Liability of members.

5. No member of the Board shall incur any personal liability for any loss or damage caused by any act or omission in the administration of the affairs of the Board, unless such loss or damage is occasioned by an intentionally wrongful act or omission on his part.

Administration.

6. (1) The Board may from time to time appoint and employ, at such remuneration and on such terms as it may think fit, such officers and servants as may be necessary in the opinion of the Board for the purposes of this Ordinance.

F.M.S. Cap. 45.

(2) All members, officers and servants of the Board shall be deemed to be public servants within the meaning of the Penal Code.

Functions of the Board.

7. The Board shall—

(*a*) promote research into the production, consumption and uses of natural rubber;

(*b*) co-ordinate activities within and outside the Federation relating to research, development, publicity and other matters affecting the natural rubber industry;

(*c*) obtain information on synthetic rubber and other like products and materials and stimulate the use of natural rubber either in competition therewith or as complementary thereto;

(*d*) control the activities and policies of all research and development organisations wholly or mainly financed by the Fund;

(*e*) ensure that it is kept fully informed on the activities and policies of all research and development organisations partly financed by the Fund;

(*f*) keep the Minister fully informed on all matters relating to research into and the development of natural rubber and the natural rubber industry;

(*g*) administer the Fund;

(*h*) perform such other functions as the Minister may, after consultation with the Board, from time to time prescribe.

Issues of policy.

8. (1) The Board shall keep the Minister informed of the policy pursued or intended to be pursued by the Board.

(2) The Minister may from time to time issue directives to the Board as to the policy to be pursued by the Board; and any such directive shall become binding on the Board, which shall forthwith take all steps necessary or expedient to give effect thereto.

(3) If the Board objects to any such directive, the Board may submit its objections and the reasons therefor in writing to the Minister, who shall cause the same, together with his directive, to be laid before the House of Representatives.

Part II

CONTROLLER OF RESEARCH

Controller of Rubber Research and Deputy Controller of Rubber Research.

9. (1) For the purposes of this Ordinance there shall be appointed a Controller of Rubber Research, and there may be appointed a Deputy Controller of Rubber Research.

(2) The Controller shall be the principal executive officer of the Board and may in accordance with the directions of the Board make contracts and transact all other business on behalf of the Board :

Provided that no person entering into a contract or having other dealings with the Board shall be bound to inquire whether any directions of the Board have been made or complied with.

10. (1) The Controller and the Deputy Controller shall be appointed by the Minister on the advice of a Selection Committee consisting of— Appointment of Controller and Deputy Controller.

(*a*) two representatives appointed by the Minister; and

(*b*) two representatives appointed by the Rubber Producers' Council.

(2) The Selection Committee shall—

(*a*) prescribe the terms and conditions of service of the Controller and Deputy Controller;

(*b*) invite applications for the post of Controller and Deputy Controller;

(*c*) consider all applications for the post of Controller and Deputy Controller and interview such applicants as it may consider necessary;

(*d*) advise the Minister in writing of the name of the applicant recommended for appointment as Controller or Deputy Controller as the case may be.

(3) The procedure of the Selection Committee shall, subject to the provisions of this Ordinance, be regulated by the Committee.

(4) In exercising its powers and performing its duties under this Ordinance the Selection Committee may co-opt such advisers or assessors as it may think fit:

Provided that no such adviser or assessor shall have any vote in any proceeding of the Committee.

11. (1) Upon any vacancy occurring in the office of Controller the Minister shall, and upon any vacancy occurring in the office of Deputy Controller the Minister may, request the Rubber Producers' Council to appoint the two representatives referred to in paragraph (*b*) of sub-section (1) of section 10. Procedure for appointment of Controller and Deputy Controller.

(2) If the Rubber Producers' Council shall fail to comply with any request under sub-section (1) within three months from the date thereof, or if a Selection Committee shall fail within three months from the date of the constitution thereof under sub-section (1) of section 10 to make any recommendation under paragraph (*d*) of sub-section (2) of section 10 the Minister may himself forthwith appoint a Controller or a Deputy Controller as the case may be and

may for that purpose exercise all or any of the powers referred to in paragraphs (*a*), (*b*) and (*c*) of sub-section (2) of section 10:

Provided always that the Minister may in his discretion permit an extension of any such period of three months.

(3) The services of the Controller or Deputy Controller may not be terminated by the Minister except after consultation with the Board.

Deputy Controller.

12. (1) If, during any period, owing to absence or inability to act from illness or any other cause the Controller is unable to exercise the powers or perform the duties of his office, the Deputy Controller shall, during any such period, exercise the powers and perform the duties of the Controller, subject to such conditions, exceptions and qualifications as the Minister may from time to time direct.

(2) In the event of the office of Deputy Controller being for the time being vacant, the Minister may from time to time during the absence of the Controller or his inability to exercise the powers or perform the duties of his office from illness or any other cause direct that all or any of such powers or duties may be exercised or performed by a member or officer of the Board subject to such conditions, exceptions and qualifications as the Minister may from time to time direct.

Part III

MALAYAN RUBBER FUND

Establishment of Fund.

13. The Board shall establish and maintain a fund, to be called the Malayan Rubber Fund, into which shall be paid all monies received by the Board.

Cess and contributions.

14. (1) (*a*) The Minister may, after consultation with the Board, make orders for the imposition, collection, variation or cancellation of a cess on rubber exported from the Federation.

(*b*) Except in so far as may be otherwise provided in any such order such cess shall be deemed for the purposes of collecting and enforcing the collection thereof to be a customs duty imposed under the Customs Ordinance, 1952. *42 of 1952.*

(*c*) Every such order shall be published in the *Gazette* and shall be laid on the table of the House of Representatives as soon as practicable after the publication of such order in the *Gazette*.

(*d*) All monies collected under any such order shall be paid into the Fund.

(2) Any monies which may be received from any government, or any organisation outside the Federation, which may have been accepted as a participant in the benefits of the work carried out by or on behalf of the Board shall be paid into the Fund.

Application of Fund.

15. The Fund shall be applied for the following purposes :

(*a*) the management and expenses incurred in the administration of the Fund, including the remuneration of the Controller, Deputy Controller and officers and servants of the Board, pension rights and contributions to any provident fund established by the Board;

(*b*) research, development and publicity for increasing or stimulating the production and consumption of natural rubber, reducing the cost of production and processing, improving the qualities of natural rubber and disseminating information relating thereto;

(*c*) the contribution of funds to the Rubber Research Institute of Malaya, the British Rubber Producers' Research Association and the Natural Rubber Development Board;

(*d*) contributions to international bodies of which the Federation is a participating member dealing with the supply of and demand for natural rubber or with research upon and development of natural rubber;

(*e*) contributions to the Rubber Producers' Council;

(*f*) the payment of such allowances and expenses, at such rates as the Minister may from time to time approve, to members, officers and servants of the Board or of any Selection Committee, or to any adviser or assessor co-opted to any such Committee;

(*g*) the payment of all advertising and clerical expenses arising in connection with the appointment of a Controller and a Deputy Controller;

(*h*) any other purpose relating to rubber research prescribed by the Minister after consultation with the Board.

Investment.

16. Any part of the Fund not immediately required to be expended may from time to time be invested in the Federation in securities approved by the Minister, or outside the Federation in securities approved by the Minister charged with responsibility for finance.

Accounts and audit.

17. (1) The Board shall keep a full and correct account of all monies received and spent by it and at the end of each calendar year submit a report of its operations, accompanied by a statement of its revenue and expenditure, to the Minister and to the Rubber Producers' Council.

(2) The accounts of the Fund shall be audited annually by the Auditor-General.

(3) An annual abstract of the revenue and expenditure of the Board shall be published in the *Gazette* together with the report of the Auditor-General.

Part IV

TRANSITIONAL AND REPEAL

Repeal and transitional.

18. Upon the coming into force of section 14—

(*a*) the enactments specified in the first and second columns of the Schedule hereto are hereby repealed to the extent specified in such Schedule;

(*b*) any monies or securities standing to the credit of or any liabilities against the Malayan Rubber Fund under any enactment specified in the Schedule hereto immediately prior to the coming into force of section 14 shall be forthwith transferred to the Fund;

(*c*) any customs duty or duties imposed on the export of rubber from the Federation under the Customs Ordinance, 1952, and collected under the Third Schedule of paragraph (*h*) of Table B of the Customs Duties Order, 1956, as in force on the date of the coming into force of section 14 shall, except in so far as such duty or duties have not then been paid into the fund constituted under any enactment specified in the Schedule hereto, be deemed to be a cess imposed for the purposes of this Ordinance by an order under sub-section (1) of section 14. *42 of 1952.*

SCHEDULE

(Section 18)

Number and year of Enactment	Short title	Extent of repeal
Federated Malay States 37 of 1936	Rubber Regulation Enactment, 1936	Section 16
Johore 1 of 1937	Rubber Regulation Enactment, 1937	Section 20
Kelantan 2 of 1937	Rubber Regulation Enactment, 1937	Section 16
Kedah 23 of 1355	Rubber Regulation Enactment ...	Section 16
Trengganu 45 of 1356	Rubber Regulation Enactment ...	Section 11
Perlis 3 of 1353	Rubber Regulation Enactment, 1353	Section 9
Straits Settlements 4 of 1939 ...	Rubber Regulation Ordinance, 1939	Section 12

Passed in the Legislative Council on the fourth day of December, 1958.

C. A. FREDERICKS,
Clerk of the Legislative Council

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SCHEDULE

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